THE PHILIPPINE
JOURNAL OF SCIENCE

VOL. 58 NOVEMBER, 1935 No. 3

LYMNÆA PHILIPPINENSIS, AN INTERMEDIATE HOST OF FASCIOLA HEPATICA IN THE PHILIPPINES, WITH SOME OBSERVATIONS ON THE BIONOMICS OF THE PARASITE.[1]

By ZACARIAS DE JESUS

Of the Veterinary Research Division, Bureau of Animal Industry, Manila

ONE PLATE

INTRODUCTION

The complicated life history of the common liver fluke of ruminants, *Fasciola hepatica* Linnæus, 1758, was thoroughly studied by Thomas (1883) and Leuckart (1879, 1886). Later the various phases of the life history were further elucidated by Ssinitzin (1914), Shirai (1925, 1927), Ross and McKay (1925, 1929), Ross (1930), Shaw and Simms (1930), Shaw (1932), Krull (1933), and Stewart (1934). In all cases only definite species of snails indigenous in certain countries and belonging to the family Lymnæidæ Keferstein were found to be the indispensable intermediate hosts in the complete life cycle of this trematode parasite.

The importance of the determination of the specific intermediate host of this liver fluke lies in the fact that it would greatly help veterinarians to institute definite measures in the control and prevention of fascioliasis in ruminants. In other countries the snail intermediate hosts of *F. hepatica* have been determined. In England and continental Europe, according to Thomas (1883)

[1] Bureau of Animal Industry Technical Bulletin 8. Read before the Philippine Society of Parasitology, July 17, 1935.

and Leuckart (1886), the host is *Lymnæa truncatula* (Müll.). In Japan *Lymnæa pervia* Martens was determined as host by Shirai (1925) and in Australia *Lymnæa brazieri* Smith, by McKay (1926). *Galba cubensis* was established as a host in Porto Rico by Van Volkenberg (1929) and Hoffman (1930). Sinitsin (1929) discovered that *Galba bulimoides techella* Halderman from Louisiana is an intermediate host of *F. hepatica*. *Galba bulimoides* Lea, *Galba ferruginea* Halderman, and *Fossaria modicella* Say were determined as hosts in the western part of the United States by Shaw (1929), Shaw (1931), and Krull (1933), respectively. In Argentina Bacigalupo (1933) considers *Lymnæa viatrix* d'Orb a probable intermediate host of *F. hepatica*, and in India, Bhalerao (1933) definitely determined that *Lymnæa acuminata* is a host of *Fasciola gigantica*, which is a species related to *F. hepatica*.

In the Philippines the molluscan intermediate host of *F. hepatica* has not been definitely identified despite the fact that 19 per cent of mature cattle, according to Robles (1932), from different cattle-raising provinces and brought to Manila for slaughter, were found post mortem to be infested with liver flukes. It is highly probable, however, that under field conditions the incidence of infestation is higher, because some infested animals die at an early age. Thus, Tubangui (1935) points out that one of the unsolved problems in veterinary parasitology in the Philippines is the determination of the intermediate host of the common liver fluke of ruminants. While no case of human infestation with *F. hepatica* has been reported in the Philippines, many cases have been recorded in other countries and more recently Bacigalupo (1933) and Chatron (1933) have added to the already long list of recorded cases.

The present study is an attempt definitely to determine the molluscan intermediate host in the Philippines of *Fasciola hepatica* and incidentally to make some observations on the bionomics of this trematode under local climatic conditions.

COLLECTION OF LYMNÆID SNAILS

In August and September, 1934, the writer collected a great number of species of snails belonging to the family Lymnæidæ from swamps, rice paddies, *barit* grass fields, and irrigation ditches in Laguna, Bulacan, and Pampanga, particularly in certain localities that were known to have had cases of fascioliasis in ruminants. These lymnæid snails were *Amphipeplea* spp., *Planorbis* spp., *Gyraulus prashadi* Faustino, *Physa* spp., and

Lymnæa philippinensis Nevill. They were cultured in large trays and pans the bottoms of which were covered with mud and water and various hydrophytes.

EXAMINATION OF THE SNAILS FOR NATURAL INFECTION WITH LARVAL TREMATODES

Fifty of each species of lymnæid snails in the collection were examined for larval trematodes by gently breaking up their soft shells, then teasing out the livers and examining them under a microscope. About 20 per cent of both *Planorbis* spp. and *G. prashadi* and only about 2 per cent of *L. philippinensis* naturally harbored sporocysts, rediæ, and cercariæ. On the other hand all *Amphipeplea* spp. and *Physa* spp. in the collection were negative.

ATTEMPTS TO INFECT LABORATORY ANIMALS WITH THE CERCARIÆ NATURALLY FOUND IN THE SNAILS

No attempt was made to determine morphologically the species of these cercariæ, but they were tried for their infectivity.

August 24, 1934, several *G. prashadi, Planorbis* spp., and one *L. philippinensis* were observed shedding cercariæ. The first two were cultured together in one tray and the last one in another tray. Pieces of leaves and tender stems of several species of hydrophytes were immersed in the water in the snail cultures from August 24 to September 17, 1934, inclusive. Then, these leaves and stems were fed to six guinea pigs. When killed and examined four months later all these guinea pigs were found negative for liver flukes.

DISCOVERY OF THE MOLLUSCAN INTERMEDIATE HOST

In September, 1934, many *Lymnæa philippinensis, Amphipeplea* spp., and *Physa* spp. were collected every week from a barit grass field just outside the town of Biñan, Laguna. Examinations of fifty individuals of each species in this collection revealed that they were all negative for larval trematodes.

September 8, 1934, both species were cultured in one large tray and were subjected to artificial infection with miracidia of *Fasciola hepatica* hatched from ova collected from the gall bladders of infested cattle and carabaos. There were about twenty miracidia to every snail. Three weeks later all of the one hundred twenty *L. philippinensis* and eleven of the fifty *Amphipeplea* spp. had died, but none of the twenty-seven *Physa* spp. died. But in the uninfected culture, or control, of *L. philippinensis,* only a few of the mature individuals died. Examinations of the

snails that were found dead in the culture in the morning and in the afternoon during the third week of infection showed that all the *L. philippinensis* were heavily infested with sporocysts and rediæ. The death of all the *Lymnæa* snails in the infected culture must have been due to heavy infection with larval stages of *F. hepatica*, which, as Rees (1931) points out, leads to the disintegration of the host's tissues. Of the *Amphipeplea* snails that died and those that remained alive, as well as all the *Physa* snails, none were found positive.

A great number of miracidia were placed in a watch glass containing a thin layer of water. When observed through a binocular microscope they appeared to be almost uniformly distributed. But as soon as a *L. philippinensis*, whether young or old, was placed in the same watch glass the miracidia seemed to be excited and swarmed toward the snail like an advancing and thickening cloud ring around the mollusk. Some of them darted and pierced the head and foot of the snail, while others were actually seen burying themselves in the foot of the snail. This method of observing the actual penetration of the miracidium into the intermediate host is just a slight modification of that adopted by Barlow (1925) in the case of *F. buski* and by Tubangui and Pasco (1932) in the case of *Euparyphium ilocanum*.

IDENTITY AND HABITS AND DISTRIBUTION OF LYMNÆA PHILIPPINENSIS NEVILL

The snail was identified as *Lymnæa philippinensis* Nevill by Dr. J. Bequaert, of Harvard University, to whom shells and preserved specimens were submitted through the kindness of Dr. M. A. Tubangui, of the Bureau of Science. This snail (Plate 1, figs. 1 to 6) is described by Nevill (1881) as follows:

> Shell scarcely rimate, small, horn coloured, conically globose, longitudinally striate under the lens; spire short, apex rather pointed; whorls four, the upper ones very small, scarcely convex, the last one very large in proportion, tumidly ventricose; aperture ovate, large, proportionately unusually broad, margins joined by a thin callosity, outer margin boldly, convexly rounded; columella straight, very slightly twisted, broadly reflected, rounded at base.
>
> Long 8½, diam. 5½; apert. alt. 5¾, lat. 4 mil.
>
> Hab.—Lucban, Luzon (Philippines), coll. R. Hungerford Esq.

In describing this snail, Rehn (1893) states that *Lymnæa* (*Fossaria*) *philippinensis* Nevill is very closely related to *L. pervia* Martens, of Japan and China. The latter is the very species of snail that was discovered by Shirai (1925) to be an intermediate host of *F. hepatica* in Japan.

In nature and during life, this small snail possesses a dark color (Plate 1, figs. 1 and 2) varying from dark brown to black, depending upon the color of the mud in the habitat. Whitish spots about 1 millimeter in diameter are sparsely scattered all over the body so that upon closer observation the mollusk assumes a mottled appearance. Its shell is so brittle that it can be easily crushed betwen the thumb and index finger.

This snail is amphibious in habit. It can be seen on stems and leaves of plants and on floating débris a few millimeters above the surface of the water. When on the sides of grass-covered dikes of rice paddies, it may climb as high as 10 centimeters above the water. On drying mud in the laboratory individuals remain viable for seven to twelve days, most of them hiding in the cracks.

The spread of the species in a locality is facilitated by its ability to swim and by its habit of clinging to floating débris. Hence it can be carried by water from place to place. In swimming its position is upside down, its shell being submerged while its foot is spread about the level of the surface of the water. It can submerge or float at will. Many specimens were actually collected from the surface of the water in irrigation ditches. It is found in swamps, ponds, pools, rice paddies, barit grass fields, slow-flowing streams, and irrigation ditches. The writer failed to find it in rice paddies that are dry during the dry season.

The snail is widely distributed in the Philippine Islands. The writer found this mollusk in great numbers in Pampanga, Bulacan, Laguna, and Rizal Provinces, and in swamps in Manila. Literature on this snail and the collection in the Philippine National Museum show that it is also found in Samar, Leyte, Cebu, Tayabas, and Batangas Provinces. Through the courtesy of Drs. Vicente Ferriols and Estefano C. Farinas and the field veterinarians of the disease control division, Bureau of Animal Industry, specimens of this snail are being collected in various parts of the Philippines. It has been found that this snail also occurs in Occidental Negros and Pangasinan Provinces.

EXPERIMENTS AND RESULTS

DETERMINATION OF THE INCUBATION PERIOD OF THE OVA OF FASCIOLA HEPATICA DURING THE WET AND DRY SEASONS

Experiment 1.—Ova of *Fasciola hepatica* were collected from the gall bladders of infested cattle and carabaos at the Manila Matadero. These were washed many times with plain tap water

and were cultured in aquaria the bottoms of which were covered with sand and gravel. The water was from 1 to 5 centimeters deep and was replenished whenever necessary, and plenty of common algæ and other hydrophytes were provided to balance the aquaria. The cultures were kept in the laboratory with glass walls and windows, and were so placed close to the windows that they were exposed to direct sunlight from 6.30 to 9 a. m.

In four trials during August and September, 1934, which fall within the wet season in the Philippines, the eggs began to hatch after an incubation period of from eleven to thirteen days and the hatching continued for ten to fifteen days. In three trials during April, 1935, which falls within the dry season, the eggs began to hatch after an incubation period of from ten to eleven days and the hatching continued for ten to fifteen days.

DETERMINATION OF THE PROBABLE PERIOD REQUIRED TO COMPLETE THE INTRA-MOLLUSCAN DEVELOPMENT

Experiment 2.—October 26, 1934, many young *Lymnæa philippinensis* were collected from a rice paddy in Biñan, Laguna. Only one of the fifty snails examined was found to be infested with sporocysts, rediæ, and cercariæ. The remaining one hundred twenty snails were cultured in one large tray containing some water and a layer of mud on which were scattered some common algæ and other hydrophytes to simulate the natural habitat of the snails. Every twenty of these snails were exposed for two hours to from thirty to fifty miracidia in a Petri dish. The culture was placed closed to a window in a corner of the laboratory with glass walls and windows so that the tray was exposed to direct sunlight from 6.30 to 9 a. m. The dead and inactive snails in the culture were examined for the different forms of trematode larvæ, and in the fourth and fifth weeks the snails that survived were placed every morning in beakers with water 1 centimeter deep, and observed every thirty minutes until late in the afternoon.

November 3, 1934, or eight days after infection, all of the five snails examined contained young sporocysts, but no rediæ were found; and November 19, 1934, or twenty-four days after infection, most of the snails examined harbored rediæ, some of which contained undeveloped cercariæ, while the others contained sporocysts.

November 30, 1934, or thirty-five days after infection, two of the remaining twenty-three snails were shedding cercariæ; December 3, 1934, or thirty-eight days after infection, five other

snails began to shed cercariæ; and December 7, 1934, or forty-one days after infection, three other snails began to shed cercariæ.

December 14, 1934, or forty-eight days after infection, one of the surviving eleven snails began to shed cercariæ; this snail died the next day. December 17, 1934, or fifty-one days after infection, all the remaining ten snails died. Upon examination they were found to harbor rediæ, most of them with fully developed cercariæ.

LIBERATION OF THE CERCARIÆ AND THE FORMATION OF CYSTS

Experiment 3.—December 4, 1934, four of the five snails that were observed to shed cercariæ on the previous day, as mentioned in experiment 2, were placed in a large beaker containing a little water and some algæ. Examinations for the presence of cercariæ were made every thirty minutes from 7.30 a. m. to 6.30 p. m., inclusive. At 1 p. m. seven cercariæ were found actively swimming in the water. The number of cercariæ increased rapidly at 3 p. m. At 6 p. m. several cysts were seen on the sides of the beaker about the level of the surface of the water. At 6.30 p. m. all four snails were still shedding cercariæ.

December 5, 1934, at 7 a. m. no more free-swimming cercariæ were seen, but many cysts were found attached to the sides and bottom of the beaker and to the shells of two of the snails. The cysts were removed from this culture. At 12 noon one free-swimming cercaria was seen in the culture, and at 1 p. m. every snail was already shedding cercariæ. Pieces of stems and leaves of several species of hydrophytes were immersed in the water in the culture. Cysts were observed to form on the plants even as early as 4 p. m. The next morning cysts were found attached to pieces of leaves and stems of plants as well as to the sides and bottom of the beaker.

December 6, 1934, at 7.45 a. m., two of the four snails in the beaker culture were found dead. At 11.30 a. m. one snail began to shed cercariæ, and at 12 noon both snails were shedding cercariæ and were still shedding cercariæ at 6.45 p. m. The next day the last two snails died in the morning. Each had several rediæ and many fully developed cercariæ.

One snail shedding cercariæ was cultured in a separate beaker and was observed every day from December 3, 1934, until it died. It shed 32 cercariæ the first day, 78 the second day, 149 the third day, and 110 the fourth day, or a total of 369 cercariæ. When it died it was found to contain three young rediæ

and two old ones containing about one hundred fully developed cercariæ and many more undeveloped ones.

The formation of cysts was observed to be accomplished in fifteen to forty-five minutes from the time a free-swimming, actively motile cercaria settles on a solid object. At first it sticks to a point by its suckers; its body contracts and becomes circular in outline. In the meantime the tail keeps on lashing and wiggling and later snaps off at the base. As shown in Plate 1, figs. 7 and 8, the cysts appeared like tiny moles measuring about 0.2 millimeter in diameter and about 0.1 millimeter in thickness. They are yellowish white in color. Mere washing of the leaves and stems of plants to which they were attached did not dislodge them.

INFECTION EXPERIMENTS

Besides rabbits and guinea pigs, goats were also used in the infection experiments. The young goats were born and raised in a pen with a cement floor and were fed only with guinea and napier grasses from a well-drained field. These young goats or kids as well as their mothers were found negative for ova of *Fasciola hepatica* on repeated fæcal examinations.

INFECTION WITH FREE-SWIMMING CERCARIÆ

Experiment 4.—December 3, 1934, each of four guinea pigs and one rabbit was drenched with water containing twenty-five free-swimming cercariæ coming from five snails. When killed and examined April 2, 1935, these guinea pigs and the rabbit were negative for liver flukes.

December 5, 1934, goat 79 was drenched with water containing one hundred free-swimming cercariæ coming from five snails. When killed and examined March 23, 1935, it was found negative for liver flukes.

December 6, 1934, rabbit 1 was fed with fifty free-swimming cercariæ coming from two snails. This rabbit was later found negative for liver flukes when killed and examined April 2, 1935.

INFECTION WITH ENCYSTED CERCARIÆ

Experiment 5.—December 3, 1934, goat 47 was fed with seventeen cysts from two snails, mixed with pieces of stems of guinea grass. When the goat was killed and examined March 23, 1935, or one hundred ten days after infection, two mature *Fasciola hepatica* were found in the liver.

December 14, 1934, rabbit 2 was fed with many pieces of stems and leaves of guinea grass and kangkong [*Ipomœa reptans* (Linn.) Poir.], which had been immersed for seven days in the water in the culture described in experiment 2. When the rabbit was killed and examined February 5, 1935, or fifty-three days after feeding, several immature *F. hepatica*, measuring from 8 to 18 millimeters long, were found in the liver.

FIELD EXPERIMENT

Experiment 6.—A small area, measuring 6 by 10 meters, in a barit grass field in Pandacan, Manila, was fenced. The snails found in this fenced area were *Pila luzonica* (Reeve), *Vivipara angularis* Müller, *Melania* spp., *Amphipeplea* spp., *Planorbis* spp., *Gyraulus prashadi* Faustino, *Physa* spp., *Assiminea* sp., *Stenogyra* sp., and a few *Lymnæa philippinensis* Nevill. Over five hundred more *L. philippinensis*, from Biñan, were scattered in this area. The water was from 1 to 15 centimeters deep and the barit grass that was grown here was from 30 to 40 centimeters high.

October 21, 1934, a great number of miracidia and embryonated eggs of *Fasciola hepatica* were scattered in the field. November 20, 1934, or thirty days later, twenty-one of the twenty-five *L. philippinensis* examined were found positive for rediæ, some of which contained cercariæ; and December 2, 1934, or forty-two days later, none of the seventy-seven *L. philippinensis* collected from the infected field shed cercariæ. December 4, 1934, or forty-four days after the miracidia were scattered in the field, three of the fifty *Lymnæa* snails were shedding cercariæ. All of these snails were returned to the field.

December 14, 1934, or fifty-four days after the field was infected, two of the eleven *Lymnæa* snails collected were shedding cercariæ, while seven of the remaining nine were positive for sporocysts, rediæ, and cercariæ, and two were negative.

FEEDING THE GRASS FROM AN INFECTED FIELD

December 2, 1934, or forty-two days after the field was infected, some of the barit grass was cut and fed to goat 78. Some of the stems of the grass were cut a little below the surface of the water. When this young goat died of pneumonia January 10, 1935, or thirty-nine days later, it was negative for liver flukes.

December 7 and 8, 1934, or forty-seven to forty-eight days after the field was infected, two wheelbarrows of barit grass, which had been cut and immersed in water in the infected area for twenty-four to forty-eight hours, was fed to an old bull, B. A. I. 3338. This bull was brought from Tanauan, Batangas, where it was raised and always tied, being a work animal, on a farm in Barrio Kale, situated on a well-drained plateau, with neither brook nor spring in the vicinity. In the Bureau of Animal Industry in Pandacan, Manila, it was fed with dry, old rice straw and some napier grass from a well-drained field and had been always tied in a shed with cement floor since May 31, 1934. Repeated fæcal examinations showed that the animal was negative for ova of both trematodes and nematodes. When this bull died of babesiosis February 2, 1935, or fifty-six days after the last feeding, it was found post mortem to be heavily infested with immature *Fasciola hepatica* from 8 to 17 millimeters long.

DISCUSSION

In this investigation *Lymnæa philippinensis*, a snail indigenous and widely distributed in the Philippine Islands, is definitely determined for the first time as the intermediate host of *Fasciola hepatica*. This finding will certainly give a more definite working basis for the control and prevention of fascioliasis in ruminants in the Philippines.

The incubation period of the eggs of *Fasciola hepatica* is from eleven to thirteen days during the wet season and from ten to eleven days during the dry season. According to the Philippine Weather Bureau, the average temperature in Manila from 1885 to 1933 is from 24.7° to 28.4° C. These results are in agreement with those of Ross and McKay (1929) when they incubated the eggs at a temperature of 26° to 27.5° C. and when they hatched the eggs at room temperature during midsummer in New South Wales when the temperature ranged from 18° to 30° C., which is almost the same range as the prevailing temperature in Manila throughout the year. On the other hand, in Oregon Shaw (1931) reports that the eggs of *Fasciola hepatica* have been known to hatch over a period of thirteen months. Thomas (1883) points out that a temperature of about 23° to 26° C. is most favorable. Hence, the prevailing temperature in the Philippines throughout the year is very favorable for the incubation of the ova of *F. hepatica*.

In this investigation, the intramolluscan development was completed in from thirty-five to forty-eight days after infection

under laboratory conditions, but in the field, it was from forty-four to forty-eight days. This is quite in agreement with the result obtained by Krull (1933), who reports that snails (*Galba modicella*) began to shed cercariæ thirty-two to forty-two days after they had been subjected to the miracidia in summer; and also with that obtained by Ross and McKay (1929), who found cercariæ escaping in summer in a minimum period of forty-nine days after infection of the host (*Lymnæa brazieri*). In Japan Shirai (1925) observed the mature cercariæ coming out of *Lymnæa pervia* in from forty-five to seventy days after infection. On the other hand, in Oregon Shaw (1932) found that cercariæ from artificially infected snails (*Galba bulimoides*) were discharged four months twenty-seven days after infection. The duration of the shedding of cercariæ could not be ascertained, because the snails died after shedding every day for two to four days. The high prevailing temperature in the Philippines may account for the relatively short period of the intramolluscan development herein reported.

In no case was an infected *Lymnæa philippinensis* observed to shed cercariæ in the morning. Most infected snails began to shed cercariæ between 12 noon and 1 p. m. The earliest time observed was 11.30 a. m., and this was observed but once. Rees (1931) observes that under normal conditions certain species of cercariæ, like *C. limbifera* (Seifert) and *Cercaria "Z"* (Rees), emerged during the daytime only. This author also observes that continual darkness causes a decrease in the numbers emerging, a lowering of the temperature partially or completely checks the escape of the larvæ. Cort (1922) asserts that the emergence of echinostome larvæ during the daytime only is due to the positive reaction of these larvæ to light, but Rees (1931) states that in all cases this phenomenon cannot be attributed to positive phototropism, because she found *Cercaria "Z"* to be negatively phototropic and *C. limbifera* positively phototropic, yet both these larvæ emerge during the daytime and not during the night under normal conditions. Thus, this investigator asserts that a possible explanation seems to be temperature in that the gradual rise of temperature during the day may accelerate the rate of development of the cercariæ and so bring about their emergence. Since no free-swimming cercariæ could be seen at 6 a. m. the next day, the shedding of cercariæ must have stopped sometime late in the evening of the previous day.

In the laboratory, in the presence of pieces of stems and leaves of grass, encystment was observed to begin between 5 and 6

p. m., and only in one instance at 4 p. m. Then, at 6 a. m. the next day, no more free-swimming cercariæ could be found, as all had already encysted so that all the cercariæ must have encysted late in the evening.

The highest point on the sides of the beaker where the cysts were found attached was about 5 millimeters above the water level. Ssinitzin (1914) observes that cercariæ may encyst on plants to a depth of 2 centimeters below the water level and even up to 2 centimeters above the water level. In the present study the water in the beaker was only 1 centimeter deep, and most of the cysts were found on the bottom of the beaker or on the pieces of stems of plants placed thereon. Ross and McKay (1929) report that where snails excreted cercariæ in water not more than 2 centimeters deep 6 per cent of the cercariæ would encyst on the dish rather than on water weeds or sides of the dish and that where the water was less than 2 centimeters deep up to 10 per cent of the cercariæ would encyst on the bottom. Later, Ross (1930) observes that the cercariæ would encyst at very much greater depths, from 4.5 to 10.5 centimeters.

In the present study no experiments were performed on the resistance of the cysts. However, Shirai (1927) found that the cysts could remain alive for eighty days in fresh water at a temperature of about 22° to 31° C., which is almost the same as the prevailing temperature in the Philippines. According to this author the cysts adhering to the leaves remained infective after having been exposed and dried under direct sunlight at 35° C. for three hours or dried in the shade at 26° C. for twenty-four hours. The same investigator found that if the cysts were dried in the shade at 25° to 32° C. for seventy-two hours they lost their infective power.

All attempts to infect susceptible animals with free-swimming cercariæ failed. This finding confirms the observation of Shirai (1927) and finds support in the work of the same investigator, who reports that the cysts are entirely noninfective within a few hours after encysting, but a certain number of the cysts reach an infective stage after the lapse of twelve hours.

Feeding cysts of cercariæ, which were liberated the preceding day, to a goat and a rabbit, resulted in the infection of these animals. In the case of the rabbit, which was killed fifty-three days after infection, the liver flukes recovered from the sinuses of the liver were immature and only from 8 to 18 millimeters long; in the case of the goat, which was killed one hundred ten days after infection, the two flukes found in the liver

were already mature but not yet laying eggs. Krull (1933) found the fæces of rabbit positive for eggs of *F. hepatica* one hundred two days after feeding the encysted cercariæ. In three experimentally infested rabbits, which were guarded against any apparent possibility of further infestation, Montgomerie (1931) recovered the flukes from the first rabbit, which died thirteen months later; from the second rabbit, which was killed two years seven months later; and from the third rabbit, which died three years one month later. The same writer observes that periodic counts of the eggs passed in the fæces did not suggest any gradual diminution of infestation, but after a preliminary rise it fell to a constant level, from which it was calculated that each fluke produced 1,181,000 eggs. In natural infestation Dizier (1933) reports a case of fascioliasis in a calf, five weeks old, wherein four adult liver flukes were found, so that this observer believes that intrauterine infection must have taken place.

Fascioliasis was produced in a bull by feeding it with grass from a field in which *Lymnæa philippinensis* abounds and where miracidia and embryonated eggs of *F. hepatica* were scattered forty-seven to forty-eight days before, but fascioliasis could not be produced in a goat, which was fed with grass from the same place forty-two days after infecting the field. However, after forty-four days, some individuals of *L. philippinensis* were already shedding cercariæ. These results prove that the intramolluscan development of *F. hepatica* under field conditions is completed in from forty-four to forty-eight days.

SUMMARY

Lymnæa philippinensis Nevill, a snail indigenous and widely distributed in the Philippine Islands, is definitely determined as an intermediate host of *Fasciola hepatica.*

This mollusk was observed to be positively chemotactic to the miracidia of *Fasciola hepatica,* and the miracidia developed into other larval stages in this host giving rise to cercariæ.

These cercariæ were definitely identified by successfully infecting a rabbit and a goat from which several specimens of *Fasciola hepatica* were recovered.

The incubation period of the eggs of *Fasciola hepatica* under local climatic conditions is from eleven to thirteen days during the wet season and from ten to eleven days during the dry season, showing that the prevailing temperature throughout the year in the Philippines is favorable for the hatching of the eggs of this liver fluke.

In the laboratory the intramolluscan development of *Fasciola hepatica* was completed in from thirty-five to forty-eight days, but in the field, in from forty-four to forty-eight days.

The emergence of the cercariæ started, in most cases, between 12 noon and 1 p. m. and very rarely before noon, while the encystment of the cercariæ took place apparently late in the evening.

All attempts to infect laboratory animals with free-swimming cercariæ of *Fasciola hepatica* have failed, showing that the free-swimming cercariæ are not infective.

Fascioliasis was successfully produced in a bull by feeding it with grass from a swampy field in which *Lymnæa philippinensis* abounds with other snails, which are known not to act as hosts, and where miracidia and embryonated eggs of *Fasciola hepatica* were scattered forty-seven to forty-eight days before.

The specimens of *Fasciola hepatica* recovered from the liver of a goat, which was killed one hundred ten days after infection, were already sexually mature with gravid uterus but not yet laying eggs.

ACKNOWLEDGMENT

Thanks are due Dr. T. Topacio, chief, Veterinary Research Division, for his interest in this study; Drs. J. D. Generoso and P. S. Sales for securing the necessary facilities for my survey work in the neighboring provinces; Dr. H. N. Reyes for his assistance; and Mr. G. Alcasid for helping me compare my snail specimens with those in the collection of the Philippine National Museum, at the Bureau of Science.

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ILLUSTRATION

PLATE 1

FIGS. 1 to 3. The intermediate host of *Fasciola hepatica* Linnæus in the Philippines, *Lymnæa philippinensis* Nevill; *1*, dorsal view; *2*, ventral view; *3*, lateral view. (Photographed by the Publications Division, Department of Agriculture and Commerce.)

4 to 6. Shells of *Lymnæa philippinensis* Nevill; *4*, dorsal view; *5*, ventral view; *6*, lateral view.

FIG. 7. A leaf of a hydrophyte showing the cysts of the cercariæ of *Fasciola hepatica* Linnæus. The cysts appear like tiny moles on the leaf and are of lighter color.

8. A piece of stem of a hydrophyte showing the cysts of the cercariæ of *Fasciola hepatica* Linnæus attached to it. (Photographed by the Publications Division, Department of Agriculture and Commerce.)

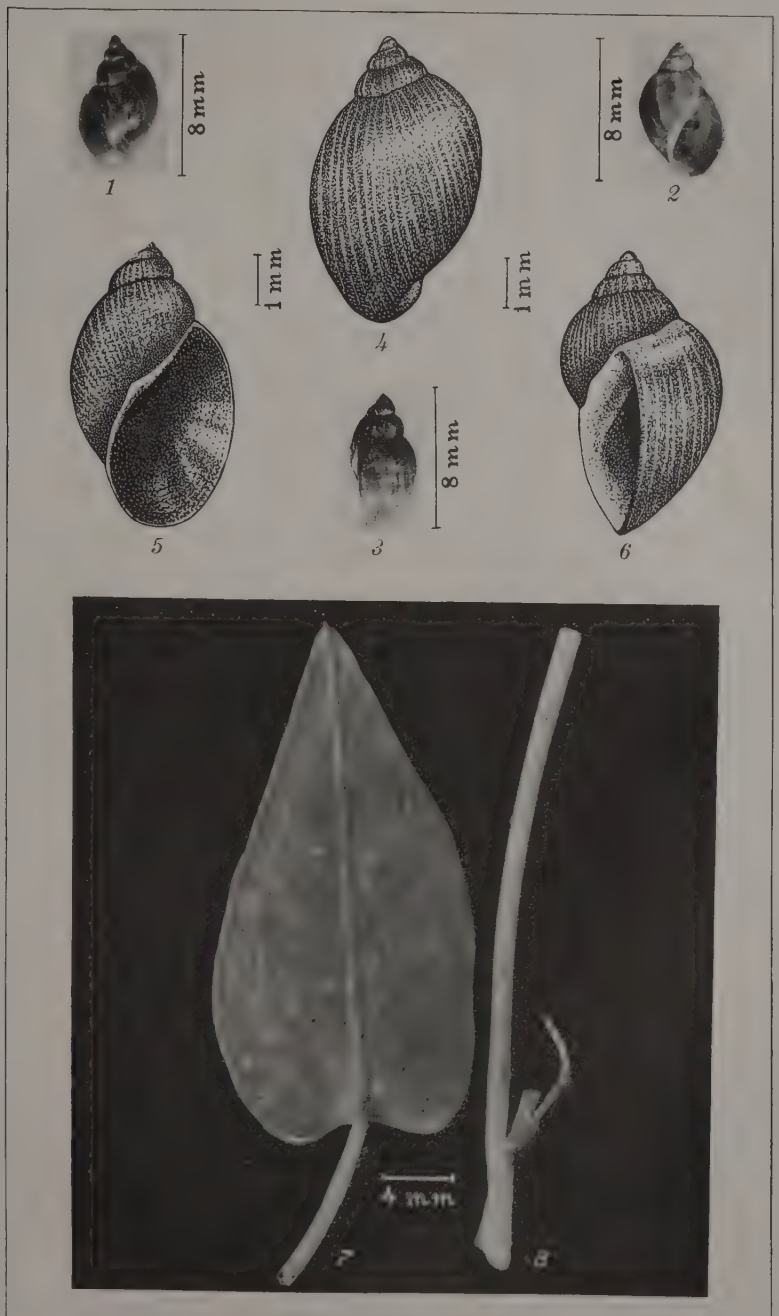

PLATE 1.

NUTRITIVE MINERAL VALUE OF PHILIPPINE FOOD PLANTS (CALCIUM, PHOSPHORUS, AND IRON CONTENTS)

By JOAQUIN MARAÑON

Of the Division of Chemical Research, Bureau of Science, Manila

Mineral constituents are a very important part of a normal diet in addition to the other necessary food requirements of the body, such as fats, proteins, carbohydrates, and vitamins.

Concerning the general functions of mineral elements in the body Sherman[1] states:

> The elements concerned in the mineral metabolism exist in the body and take part in its functions in at least three kinds of ways:
>
> (1) As constituents of the bones and teeth, giving rigidity and relative permanence to the skeletal tissues;
>
> (2) As essential elements of the organic compounds which are the chief solid constituents of the soft tissues (muscles, blood cells, etc.);
>
> (3) As soluble salts (electrolytes) held in solution in the fluids of the body, giving these fluids their characteristic influence upon the elasticity and irritability of muscle and nerve, supplying the material for the acidity or alkalinity of the digestive juices and other secretions, and yet maintaining the approximate neutrality of the body's fluids as well as their osmotic pressure and solvent power.

Three of the most important mineral elements that the body requires are calcium, phosphorus, and iron. Calcium and phosphorus are always needed in relatively liberal amounts. In addition to their various activities they constitute, as calcium phosphate, about 85 per cent of the mineral matter of bones, or at least three-fourths of the entire ash of the body.

Most of the iron in the body is contained in the blood in the form of hæmoglobins which are proteins containing iron. A considerable portion of the red blood corpuscles is composed of hæmoglobins which function as oxygen carriers in respiration.

[1] Chemistry of Food and Nutrition (1932) 237.

A few researches [2] have been carried out to determine certain mineral elements in some Philippine food plants, but as yet no extensive survey has been reported.

The object of this investigation was to determine the calcium, phosphorus, and iron contents of a large number of Philippine vegetables and fruits in order to ascertain their relative nutritive value in these important mineral constituents.

EXPERIMENTAL PROCEDURE

Both the scientific and local names of the plant materials used are given in Table 1, in which the particular parts of the plants employed for analysis are also included.

Most of the specimens were obtained from plants grown in the Philippines and purchased in the city markets of Manila during the dry (spring) season. Some were secured from other districts such as the Mountain and Laguna Provinces while a few were imported. Care was taken to select only fresh and representative specimens.

Immediately upon reaching the laboratory the plant materials were prepared for analysis. All foreign matter, such as adhering soil, was removed. Samples that had been recently watered were allowed to drain and dry in the air until the surface contained no excess water. The edible portion of the plants was separated from the nonedible, which was discarded. A small part of the fresh, edible portion of each specimen was taken for the moisture determination and the remainder was air dried in a greenhouse. The materials that tended to become moldy, when dried in the sun, were heated in an electric oven at a temperature of about 80° C., until sufficiently dry. All of the samples, when dried, were ground to a coarse powder and kept in well-stoppered bottles.

Analysis.—The plant materials were analyzed for moisture, ash, phosphorus, calcium, and iron.

[2] Adriano, F. T., and M. S. de Guzman, Philip. Agr. 20 (1931) 43.—Adriano, F. T., and E. T. Tavanlar, Philip. Agr. 14 (1925) 437.—Aron, H., Philip. Journ. Sci. § B 5 (1910) 81.—Aron, H., and F. Hocson, Philip. Journ. Sci. § B 6 (1911) 361.—Martinez, T. R., Philip. Agr. 21 (1933) 551.—Wells, A. H., F. Agcaoili, and R. T. Feliciano, Philip. Journ. Sci. 20 (1932) 353.—Vedder, E. B., and R. T. Feliciano, Philip. Journ. Sci. 35 (1928) 351.

Moisture.—The moisture content was determined by heating a portion of the sample to constant weight in a drying oven at a temperature of 100° to 105° C.

Ash.—About 20 to 25 grams of the plant material was charred at moderate heat and the charred mass was then ignited in an electric muffle furnace at a temperature of approximately 450° C. The ash was cooled in a desiccator and weighed.

The major portion of the ash, accurately weighed, was fused with sodium carbonate. The melt was boiled with dilute hydrochloric acid, the solution filtered, and the filtrate made up to a definite volume. Aliquot portions of the measured solution were used for the determination of phosphorus, calcium, and iron.

The results given in Table 2 show that the quantities of phosphorus, calcium, and iron obtained by fusing the ash with sodium carbonate are slightly higher than those obtained by directly dissolving the ash in warm, dilute hydrochloric acid.

In the case of seeds the ashing of the sample for elementary analysis was carried out in accordance with the magnesium nitrate method.[3]

Phosphorus.—This was determined in an aliquot portion of the measured acid solution (filtrate) from the ash. The official volumetric method[4] was employed except in the precipitation of ammonium phosphomolybdate where Hibbard's directions[5] were followed.

The official agricultural method for phosphorus determination in plants requires that the sample should be treated with magnesium nitrate solution before ashing. In view of the many samples to be analyzed this method of ashing was not employed except for samples of seeds. Preliminary experiments, recorded in Table 3, showed that there was only a very slight difference in the amount of phosphorus pentoxide obtained by the official agricultural method and the procedure adopted for this investigation.

Calcium.—Another aliquot part of the acid solution of the ash was used for this determination. The calcium was precipitated as oxalate and the precipitate after thorough washing was dis-

[3] Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists (1930) 110.

[4] Op. cit. 16.

[5] Journ. Indus. Eng. Chem. 5 (1913) 1000.

solved in hot sulphuric acid and titrated with potassium permanganate (0.1 *N*).[6]

Iron.—Walker's method[7] for the determination of iron in foods was adopted, using an aliquot portion of the acid solution of the ash.

RESULTS

In tabulating the results of analysis the samples were arranged according to the following groups: Leafy vegetables; nonleafy vegetables; fruits; seeds; roots, rhizomes, and tubers.

In the tables the percentages of phosphorus, calcium, and iron are expressed in terms of phosphorus pentoxide, calcium oxide, and ferric oxide, respectively, for both the fresh and moisture-free samples and also for the ash.

Leafy vegetables.—In Table 4 are given the results of analyzing leafy vegetables. As shown by the data the leafy vegetables are characterized by having a relatively high ash content. They can also be considered as excellent sources of phosphorus, calcium, and iron. Some samples, such as the different kinds of spinach obtained from the Mountain Province (samples 59, 93, 56, and 46), contained more than 20 per cent ash. The phosphorus, calcium, and iron contents of the ash were correspondingly high. These facts are more noticeable in Table 5, in which it is shown that the major portion of the leafy vegetables gave the following average results:

Constituent.	Per cent.
Ash	10.01 to 20
Phosphorus pentoxide (P_2O_5)	1.01 to 2
Calcium oxide (CaO)	1.01 to 3
Ferric oxide (Fe_2O_3)	0.01 to 0.19

While the leafy vegetables were, in general, rich in mineral constituents the young leaves of these plants gave only a comparatively small amount of ash. For example (Table 4), the young leaves of ciruelas contained only 7.20 per cent ash and those of tamarind had even less (4.50 per cent).

The data given in Table 4 show that there was a notable variation in the amount of ash obtained from different kinds of vegetables. Again, there was quite a difference in the percentages

[6] Op. cit. 104.

[7] Hawk, P. B., and O. Bergheim, Practical Physiological Chemistry (1927) 413.

of phosphorus, calcium, and iron in the ash of individual vegetables. For instance, in the leaves of the cashew plant (sample 158) the amount of ash was very small (4.28 per cent) while the percentage of phosphorus in the ash was very high (24.11 per cent). The leaves of Swiss chard (sample 314) contained 20.27 per cent ash, but the amount of phosphorus in the ash was only 3.58 per cent.

Many of the samples that had a low ash content contained more phosphorus than calcium. The ratio of calcium oxide to phosphorus pentoxide was worked out not only for the leafy vegetables but also for the other plant products analyzed, and the results are recorded in the various tables.

Nonleafy vegetables.—This group was an odd assortment of stems, pods, flowers, shoots, and a few fruits. In classifying the fruits, vegetables, and other products analyzed most of the fruits were included in a special group. However, some fruits, such as squash, tomato, and egg plant, which are eaten without leaves and are ordinarily regarded as vegetables, were considered to be nonleafy vegetables. The variation in the mineral constituents of the nonleafy vegetables (Table 6) was even greater than in the leafy vegetables. Green fruits and pods gave an ash content much lower than that of the other kinds of nonleafy vegetables but the amount of phosphorus pentoxide in the ash was very high.

The phosphorus content of the nonleafy vegetables was about the same as that of the leafy ones, but the amount of ash, calcium, and iron was much less.

A majority of the nonleafy vegetables (Table 7) gave the following range of mineral constituents:

Constituent.	Per cent.
Ash	5.01 to 15.00
Phosphorus pentoxide (P_2O_5)	0.51 to 2.50
Calcium (CaO)	0.26 to 1.25
Ferric oxide (Fe_2O_3)	0.03 to 0.05

Fruits.—Analyses of a number of different kinds of fruits are given in Table 8. In general, the mineral contituents (ash) of fruits were much lower than those of vegetables. Fruits usually contained somewhat more phosphorus than calcium, but the iron content was particularly low. Sour fruits, such as kalamansi, bignai, blueberry, and tibig, were rather high in calcium as compared to other fruits.

Most of the fruits gave average results (Table 9) as follows:

Constituent.	Per cent.
Ash	1.50 to 5.00
Phosphorus pentoxide (P_2O_5)	0.10 to 0.60
Calcium oxide (CaO)	0.02 to 0.50
Ferric oxide (Fe_2O_3)	0.01 to 0.03

Seeds.—Analyses of seeds (Table 10) gave a relatively lower ash content than those of other plant products. Seeds of *Sesamum orientale* gave the highest ash content, which was only 6.63 per cent. Rice had an exceedingly low amount of ash (0.96 per cent).

The seeds were very low in calcium and iron though the phosphorus was quite high. This abnormal, or unbalanced, proportion of phosphorus and calcium is a characteristic property of these plant products. In the case of rice, for instance, the phosphorus was exceedingly high, for the ash contained 69.38 per cent phosphorus pentoxide. However, the lime content of the ash was only 2.04 per cent.

The following data give the general trend of the seed analyses (Table 11):

Constituent.	Per cent.
Ash	2.51 to 4.50
Phosphorus pentoxide (P_2O_5)	0.35 to 1.25
Calcium oxide (CaO)	0.01 to 0.39
Ferric oxide (Fe_2O_3)	0.006 to 0.03

Roots, rhizomes, and tubers.—As far as mineral constituents are concerned, this group (Table 12) appears to occupy an intermediate position between the nonleafy vegetables (Table 6) and the fruits (Table 8).

Average analyses of most of the samples in this group (Table 13) are given below:

Constituent.	Per cent.
Ash	3.00 to 12.00
Phosphorus pentoxide (P_2O_5)	0.35 to 1.25
Calcium oxide (CaO)	0.01 to 0.50
Ferric oxide (Fe_2O_3)	0.003 to 0.04

These products had a rather low ash content. The average amount of phosphorus, though low, was considerably greater than the calcium. Most of the materials were very low in iron.

REVIEW OF DATA

Plants rich in mineral elements.—In reviewing the basic analytical results obtained in this investigation we find that some

plants, or plant products, serve as excellent sources for particular mineral elements. Data of this nature are given in Table 14 in which the names of plant materials that are very rich in phosphorus, calcium, or iron are recorded. As shown by the table the major portion of these plant materials, rich in mineral constituents, consists of leaves.

Distribution of mineral elements in different types of Philippine food plants.—Some idea of the general distribution of ash, phosphorus, calcium, and iron in a few very common (typical) types of Philippine food plants is given in Table 15. A comparison of the data pertaining to the different kinds of plant products analyzed shows again that both the leafy and nonleafy vegetables have a high ash content and are rich in mineral constituents. The leafy vegetables are, however, much higher in calcium and iron than the nonleafy. The fruits, seeds, and underground structures (roots and tubers) are, in general, poor in mineral matter (ash).

Mineral matter in different parts of plants.—Table 16 contains some interesting data in that it shows the mineral content in different parts of the same plant. In the case of ampalaya, for instance, the leaves and green fruit were found to contain about the same amount of phosphorus but the percentage of ash, calcium, and iron in the leaves was much greater than in the green fruit (samples 28 and 12). The leaves and flowers of the squash also contained much more mineral matter than the fruit (samples 35, 301, and 141).

Location and climate in relation to the mineral constituents in leafy vegetables.—The environmental conditions under which a plant is grown naturally affect the composition of the mineral matter contained in the plant.

If a plant of definite species is grown in different localities the amount of individual mineral elements in the plant may vary a good deal. As a rule, however, the general trend of the analyses is about the same. This is shown by the data in Table 17, from which a few examples are given below:

Sample No.	Local name of plant.	Place grown.	P_2O_5 in ash.	CaO in ash.	Ratio ($CaO:P_2O_5$).
			Per cent.	*Per cent.*	
20	Paco	Manila	19.46	1.89	1 : 10.30
20–A	...do	Baguio	15.65	2.38	1 : 6.58
23	Perejil	Manila	8.12	17.55	1 : 0.46
23–A	...do	Baguio	8.55	13.96	1 : 0.61

These two plants, pakó and perejil, were grown near Manila, where the climate is tropical, and also near Baguio, a summer resort situated at an elevation of about 1,500 meters in the Mountain Province of the Philippines. In this mountainous location the climate is about temperate. Specimens of these two plants were, therefore, grown under both tropical and temperate climate conditions.

The plant pakó, when grown near Manila, had a relatively large amount of phosphorus and a small amount of calcium. This is a particular characteristic of the plant, for when grown near Baguio it also had a relatively large amount of phosphorus and a small amount of calcium. The ratios of calcium oxide to phosphorus pentoxide were rather high in both cases, varying from about 1: 6 to 1: 10.

Perejil, when grown either near Manila or Baguio, had a relatively low amount of phosphorus and a high amount of calcium. The ratios of calcium oxide to phosphorus pentoxide were somewhat the same for the two samples and rather low, 1: 0.46 and 1: 0.61.

From this it appears that if a mature plant is high in some particular mineral element and low in another, when grown in a certain locality, it will have the same characteristic when grown properly in other places. There may be variation in the composition of the mineral matter contained in the plant. However, the general trend of the plant-ash analyses is about the same even though the plant is grown under both tropical and temperate climate conditions. This general relation obtains for all the other results recorded in Table 17.

Calcium-phosphorus ratio.—In normal nutrition it is not only necessary that the body should have a sufficient amount of mineral elements, such as calcium and phosphorus, but these elements should be acquired in appropriate quantities to be most effective.

According to Sherman,[8] 0.45 gram of calcium and 0.88 gram of phosphorus may be considered the minimum of actual daily need for adult humans. However, the normal allowance should be much more than this. He estimates the optimum daily allowance to be about 1 gram of calcium oxide and 3 grams of

[8] Chemistry of Food and Nutrition (1932) 512.

phosphorus pentoxide. According to this estimate the optimum calcium oxide-phosphorus pentoxide ratio is 1:3.

In the various tables of analyses the calcium oxide-phosphorus pentoxide ratio has also been included. A review of the tables shows a wide variation in the ratios for individual plants. In Table 18 are given the names of the plants that had mineral matter in which the ratio ($CaO:P_2O_5$) was approximately 1:3.

Selecting plants for proper calcium-phosphorus ratio.—Out of the large number of samples analyzed only a very few contained mineral matter having approximately the proper ratio ($CaO:P_2O_5$).

The analytical results given in the tables are of practical value. For by selecting plant materials that have appropriate ratios ($CaO:P_2O_5$) and combining them in the right proportions the resulting product will have the proper calcium oxide-phosphorus pentoxide ratio. As examples we might select the two leafy vegetables that are given below.

Two leafy vegetables (Table 4) selected to give an average ratio ($CaO:P_2O_5$) of 1:3.

Sample No.	Local name.	Calcium (CaO).	Phosphorus (P_2O_5).	Ratio ($CaO:P_2O_5$).
		Per cent.	*Per cent.*	
19	Sibuyas	0.16	0.10	1:0.6
158	Kasoy	0.05	0.27	1:5.4

To mix these two vegetables so that the combination will have an average ratio of ($CaO:P_2O_5$) of 1:3, it is only necessary to take an amount of each sufficient to yield a gram of calcium oxide.

According to the analysis 100 grams of sample 19 contain 0.16 gram of calcium oxide. Therefore, 625 grams of the sample will contain 1 gram of calcium oxide as shown by the following proportion:

$$100:0.16 = x:1$$
$$x = 625$$

Calculated in a like manner 2,000 grams of sample 158 will also contain 1 gram of calcium oxide. By mixing these two samples in these proportions the combination will have an average ratio ($CaO:P_2O_5$) of 1:3, as shown below:

Combination, by weight, of two leafy vegetables that gives an average ratio ($CaO:P_2O_5$) of 1 : 3.

Sample No.	Weight of sample.	Weight of CaO.	Weight of P_2O_5.	Average ratio ($CaO:P_2O_5$) for combination.
	g.	g.	g.	
19	625	1	0.6	1 : 3
158	2,000	1	5.4	

In this case by combining, by weight, approximately one part of sibuyas (sample 19) with three parts of kasoy (sample 158) the combination will have an average ratio ($CaO: P_2O_5$) of about 1: 3.

Combinations of three or more vegetables can be calculated in a similar manner.

For convenience these calculations were based upon fresh samples that contained moisture. Although the moisture content of all the samples was quite high, yet the moisture in individual samples did not, in general, vary more than about 10 per cent from the average moisture content of all the samples analyzed. If the analyses of moisture-free samples are used for the calculations the results obtained are about the same.

Rice is comparatively high in phosphorus and very low in calcium. In countries where the diet of the masses consists largely of rice there is a great tendency for the diet to be unbalanced and to contain an excess of phosphorus. This unbalanced ration may be balanced to a certain extent by including in the diet vegetables that have a high ash content and a relatively large amount of calcareous matter in the ash.

The common names of some vegetables that are frequently sold in the local markets are given in Table 19. These particular vegetables are comparatively high in calcium and low in phosphorus. This unbalanced mineral ratio is just the opposite of that in rice. The addition of these vegetables to a ration consisting largely of rice would tend to balance the calcium-phosphorus ratio in the rice.

Iron in Philippine food plants.—Iron is a very important food constituent. It has been estimated that an adult requires about 10 to 12 milligrams of iron in a daily diet that is otherwise adequate in other respects. Lack of iron in the diet causes nutri-

tional anæmia. As reiterated in a note published recently [9] iron, one of the oldest medicines in the world, is still one of the most dependable for certain types of anæmia. The human body is not at all efficient for absorbing and using iron, so that relatively enormous doses have to be used to give an anemic patient the needed benefits. However, there is no danger in the use of iron as it seems to be impossible to administer an overdose.

The general distribution of iron in different groups of Philippine food plants is given below:

Group of food plants.	Iron (Fe_2O_3). Per cent.
Leafy vegetables	0.02 to 0.72
Nonleafy vegetables	0.002 to 0.14
Fruits	0.002 to 0.06
Seeds	0.002 to 0.034
Roots and tubers	0.003 to 0.07

As shown by the data, the leaves of vegetables contain the highest percentage of iron. These leaves also have a high moisture content, but only a very small amount of fat and protein. They are, therefore, especially valuable as a source of iron for they can be added to the diet without greatly increasing the total food consumption.

The common names of some Philippine vegetables having leaves that are rich in iron are given in Table 20. For each sample there is given the number of milligrams of iron (Fe_2O_3) contained in 100 grams of the fresh vegetable leaves.

SUMMARY

A large number of plants and plant products were analyzed for the calcium, phosphorus, and iron contents and also for moisture and total ash.

The samples selected for analysis were classified in accordance with the following groups: Leafy vegetables, nonleafy vegetables, fruits, seeds, and roots, tubers, and rhizomes.

The analytical results obtained indicate that, in general, the leafy vegetables have a relatively high ash content and may be considered excellent sources of calcium, phosphorus, and iron.

Some vegetables with a high ash content had a rather low percentage of phosphorus, calcium, and iron. Others with a com-

[9] Science 82 (1935) Supplement.

paratively small amount of ash gave a rather high percentage of these mineral elements.

The phosphorus content of the nonleafy vegetables was about the same as that of the leafy ones but the amount of ash, calcium, and iron was much less.

In general, the mineral constituents of fruits are much lower than those of vegetables. Fruits usually contain somewhat more phosphorus than calcium, but the iron content is particularly low.

Seeds were very low in calcium and iron though the phosphorus was quite high. This abnormal, or unbalanced, proportion of phosphorus and calcium is a characteristic property of seeds, especially noticeable in the case of rice.

Roots and tubers generally have a low ash content and most of them have a very small percentage of iron.

Special tables were prepared in order to make the following information more readily available:

Names of plant materials that are very rich in phosphorus, calcium, or iron.

General distribution of mineral elements in different groups of plants and in different parts of the same plant.

Location and climate in relation to the mineral constituents in leafy vegetables.

The calcium-phosphorus ratio was used to indicate how various vegetables may be combined to get the highest nutritional value in these important mineral elements.

The importance of including vegetables high in calcium in a diet consisting largely of rice was emphasized.

A survey of the general distribution of iron in different groups of Philippine food plants showed that the leafy vegetables contained the highest percentage of iron.

The names of Philippine vegetables having leaves that are rich in iron were recorded together with the number of milligrams of iron (Fe_2O_3) contained in 100 grams of the fresh vegetable leaves.

ACKNOWLEDGMENT

The author desires to express his indebtedness to Dr. A. P. West, chief of the Chemical Research Division, Bureau of Science, for the kind help rendered in this investigation, to Dr. Eduardo Quisumbing, chief of the National Museum Division of the same bureau, for the identification of certain plants used in this investigation, and to Dr. William H. Brown for the collection of some samples analyzed.

TABLE 1.—*Names of Philippine food plants analyzed.*

LEAFY VEGETABLES.

Sample No.	Name of plant.		Part analyzed.	Remarks.
	Scientific.	Common.		
8	*Allaenthus luzonicus* (Blanco) F.-Vill	Himbaba-ó	Leaves	
19	*Allium cepa* L	Sibuyas	Leaves and bulb	
60	*Allium fistulosum* L	Cibol, spring onion	Leaves and leaf bases	
57	*Allium porrum* L	Leek	do	
15	*Allium sativum* L	Bauang, garlic	do	
18	*Allium tuberosum* Roxb	Kuchai	Leaves	
159	*Amaranthus paniculatus* L	Kudiapa	Leaves and tops	
182	*Amaranthus tricolor* L	Halon	do	
1	*Amaranthus viridis* L	Kolitis	Leaves	
158	*Anacardium occidentale* L	Kasoy, cashew	Young leaves	
9	*Apium graveolens* L	Kinchai	Leaves and petioles	
58	*Apium graveolens* L. var. *dulce* DC	Celery, kinchai puti	Petioles	White variety.
20	*Athyrium esculentum* Copel	Pakó	Leaves	
11	*Basella rubra* L	Libato, alugbati	Leaves and tops	
16	*Bauhinia malabarica* Roxb	Alibangbáng	do	
48	*Beta vulgaris* L	Remolacha, beet	Leaves	
175	Do	do	Petioles	
314	*Beta vulgaris* L. var. *cicla* L	Swiss chard	Leaves	
10	*Brassica chinensis* L	Petsai	do	
6	*Brassica integrifolia* (West) O. E. Schulz	Mostaza, mustard	do	
237	Do	do	do	Chinese mustard.
180	*Brassica napobrassica* Mill	Rutabaga	do	
4	*Brassica oleracea* L. var. *acephala* L	Koles, kale	do	
47	*Brassica oleracea* L. var. *botrytis* DC	Coliflor, cauliflower	Leaves and flower heads	
211	Do	do	do	California cauliflower.
25	*Brassica oleracea* L. var. *capitata* Hort	Repollo, cabbage	Leaves	Green leaves.
52	Do	do	do	Red leaves.
319	*Brassica oleracea* L. var. *gemmifera* Hort	Brussels sprouts	do	

TABLE 1.—*Names of Philippine food plants analyzed*—Continued.

LEAFY VEGETABLES—Continued.

Sample No.	Name of plant.		Part analyzed.	Remarks.
	Scientific.	Common.		
49	*Brassica oleracea* L. var. *italica* Plench	Sprouting broccoli	Leaves, tops, and pith of stem	
50	*Brassica pekinensis* Rupr	Wongbok	Leaves	Chinese cabbage.
41	*Capsicum frutescens* L	Siling labuyo	do	
107	*Ceiba pentandra* (L.) Gaertn	Boboy, kapok	Young leaves	
387	*Ceratopteris thalictroides* (L.) Brongn	Water fern	Leaves and tops	
844	*Chrysanthemum coronarium* L	Tunghao	Leaves	
55	*Cichorium endivia* L	Escarola, endive	do	
98	*Colocasia esculentum* (L.) Schott	Gabi	Petioles	Chinese variety.
98-A	Do	do	do	Native variety, purple.
98-B	Do	do	do	Native variety, green.
225	Do	do	Leaves	Native variety.
43	*Corchorus olitorius* L	Saluyot	Leaves and tops	
14	*Coriandrum sativum* L	Coriander, ongsoy	Leaves and petioles	
85	*Cucurbita maxima* Duch	Calabaza, squash	Leaves and tops	
86	*Gnetum gnemon* L	Bago	do	
109	*Helminthostachys zeylanica* (L.) Hook	Tukod-langit	do	
29	*Ipomoea batatas* (L.) Poir	Kamote, sweet potato	do	
2-A	*Ipomoea reptans* (L.) Poir	Kangkong, water convulvulus	do	
27	*Lactuca sativa* L	Lechugas, lettuce	Leaves	
166	Do	do	do	Head lettuce.
329	*Limnophila rugosa* (Roth.) Merr	Tala	do	
320	*Manihot utilissima* Pohl	Kamoteng-kahoi, cassava	do	Young leaves only.
117	*Mentha arvensis* L	Yerba buena	Leaves and tops	
21	*Mollugo oppositifolia* L	Malagoso, sarsalida	Leaves	
28	*Momordica charantia* L	Ampalaya, balsam pear	do	Wild form.
331	*Momordica cochinchinensis* (Lour.) Spreng	Buyok-buyok	Leaves and tops	
40	*Moringa oleifera* Lam	Malungai	Leaves	

321	*Nymphaea nouchali* Burm. f.	Tunas	Petioles	
23	*Petroselinum hortense* Hoffm	Perejil, parsley	Leaves	
335	*Phaseolus calcaratus* Roxb	Capilan	Leaves and tops	
187	*Phytolacca esculenta* van Houte	Pokeweed	Leaves	
315	*Plantago major* (L.) var. *asiatica* Decne	Plantain	do	Japanese variety.
388	*Portulaca oleracea* L	Ulasiman, purslane	do	
51	*Radicula nasturtium-aquaticum* Br. and R	Water cress	Leaves and tops	
8	*Rheum rhaponticum* L	Garden rhubarb	Petioles	
59	*Rumex ambiguus* Gren	Indian spinach	Leaves and tops	
182	*Sechium edule* Sw	Chayote	do	
133	*Solanum nigrum* L	Amantec	Leaves	
98	*Spinacia oleracea* L	American spinach	Leaves and petioles	
56	Do	Prickly-seeded spinach	do	
369	*Spondias purpurea* L	Ciruelas, cineguelas	Young leaves	
172	*Tamarindus indica* L	Sampalok, tamarind	do	
46	*Tetragonia expansa* Thb	New Zealand spinach	Leaves	
119	*Trianthema portulacastrum* L	Toston, ayam	do	
332	*Vallisneria gigantea* Graebn	Sinta-sintasan, sabutan-buaia	Young leaves	
89	*Vigna sesquipedalis* Fruw	Sitao, yard-long bean	Leaves and tops	

NONLEAFY VEGETABLES.

186	*Areca catechu* L	Buñga	Stem tip	Cabbage.
201	*Arenga pinnata* (Wurmb.) Merr	Kaong, kabo negro	do	Do.
269	*Artocarpus communis* Forst	Rimas, kamansi	Green fruit	
135	*Asparagus officinalis* L	Esparrago, asparagus	Stem tip	
200	Do	do	do	California asparagus.
205	*Bambusa spinosa* Roxb	Kauayan toto-o	Shoot	Tender portion.
268	*Benincasa hispida* (Thunb.) Cogn	Kondol, tibyayong	Fruit	
68	*Brassica oleracea* L. var. *caulorapa* Hort	Kohlrabi	Stem	
325	*Canavalia ensiformis* DC	Marutong, batao americano	Young pods	
89	*Capsicum annum* L. var. *grossum* Sendt	Sili, sweet pepper	Fruit	
151	*Capsicum frutescens* L	Chileng-bundok, native hot pepper	do	
215	*Carica papaya* L	Papaya	Green fruit	

28571—8

TABLE 1.—*Names of Philippine food plants analyzed*—Continued.

NONLEAFY VEGETABLES—Continued.

Sample No.	Name of plant.		Part analyzed.	Remarks.
	Scientific.	Common.		
185	*Cocos nucifera* L.	Niog, coconut	Stem tip	Tender portion of stem.
62	*Cucumis sativus* L.	Pepino, cucumber	Fruit	
212	Do.	do.	do.	White variety.
141	*Cucurbita maxima* Duch.	Calabasa, squash	do.	Fruit, bottle-shaped form.
142	Do.	do.	do.	Fruit, elliptical form.
143	Do.	do.	do.	Fruit, oblong form.
156	Do.	do.	do.	Fruit, flat and orbicular form.
289	Do.	do.	do.	Fruit, typical form.
290	Do.	do.	do.	Fruit, rounded form.
291	Do.	do.	do.	Common type.
801	Do.	do.	Flowers	
70	Do.	Calabasa	Fruit	Summer squash.
280	*Helianthus tuberosus* L.	Artichoke	Flower heads	
80	*Dolichos lablab* L.	Batao, sibachi	Young pods	
81	*Hibiscus esculentus* L.	Okra	Fruit	
87	*Lagenaria leucantha* (Duch.) Rusby	Upo, kalubai	Green fruit	Fruit, elongated form.
165	Do.	do.	do.	Fruit, bottle-shaped.
129	Do.	do.	do.	Chinese variety.
342	Do.	do.	do.	Japanese variety.
163	*Luffa cylindrica* (L.) M. Roem.	Patolang bilog	do.	Fruit with rough skin.
164	Do.	do.	do.	Fruit with smooth skin.
83	*Lycopersicum esculentum* Mill.	Kamates, tomato	Fruit	American tomato.
152	Do.	do.	do.	Wild form.
229	Do.	do.	do.	Native form.
12	*Momordica charantia* L.	Ampalaya	do.	

181	*Moringa oleifera* Lam	Malungai	Young pods	
202	*Musa errans* (Blanco) Teodoro var. *botoan* Teodoro	Butuan	Heart	
204	*Musa sapientum* L. var. *compressa* (Blanco) Teodoro	Saba	do	
323	*Nymphaea nouchali* Burm. f	Tunas	Ovaries	
327	*Pachyrrhizus erosus* (L.) Urb	Sincamas	Young pods	
85	*Passiflora quadrangularis* L	Granadilla	Fruit	
26	*Phaseolus vulgaris* L	Habichuelas	Young pods	Tough pods.
42	Do	String beans	do	Kentucky string beans.
337	Do	Dwarf wax beans	do	Chinese beans.
339	Do	Wonder beans	do	Kentucky beans.
78	Do	Wax beans	do	White Chinese wax beans.
146	Do	Bush wax beans	do	
147	*Phaseolus* sp	Sheeras beans	do	
22	*Pisum sativum* L	Chicharo, peas	do	Fibrous.
84	Do	do	do	Soft.
74	Do	do	do	Chinese peas.
336	*Psophocarpus tetragonolobus* (L.) DC	Segidilla, cigarillas	do	
71	*Sechium edule* Sw	Chayote	Fruit	
343	*Sesbania grandiflora* (L.) Pers	Katuray, gauaigauai	Flowers	
32	*Solanum melongena* L	Talong morado, eggplant	Fruit	Fruit, obovoid form.
88	Do	Talong	do	Fruit, elongated form.
257	Do	do	do	Japanese egg plant.
82	Do	do	do	
279	*Tamarindus indica* L	Sampalok, tamarind	Young fruits	
113	Do	Sampalok	Flowers	
17	*Vigna sesquipedalis* Fruw	Sitao puti, yard-long bean	Young pods	
45	Do	Sitao pula, yard-long bean	do	
270	*Vigna sinensis* (L.) Savi	Paayap, cowpea	do	
271	*Telosma procumbens* (Blanco) Merr	Bagbagcong	Flowers	
246	*Allium ascalonicum* L	Shallot	Leaf bases	
245	*Allium cepa* L	Sibuyas, onion	do	
248	*Allium sativum* L	Bauang, ajo, garlic	do	

TABLE 1.—*Names of Philippine food plants analyzed*—Continued.

FRUITS.

Sample No.	Name of plant.		Part analyzed.	Remarks.
	Scientific.	Common.		
208	*Achras zapota* L.	Chico	Pulp	
206	*Ananas comosus* (L.) Merr.	Piña, pineapple	do	Native.
240	Do	do	do	Hawaiian, Smooth Cayenne.
155	Do	do	do	Baguio pineapple.
128	*Anona glabra* L.	Mamon	do	
238	*Anona muricata* L.	Guayabano	do	
172	*Anona squamosa* L.	Ates, custard apple	do	
207	*Antidesma bunius* (L.) Spreng	Bignai	do	
244	*Artocarpus integra* (Thunb.) Merr	Nangka, jack fruit	do	
199	*Averrhoa bilimbi* L.	Kamias	do	
169	*Averrhoa carambola* L.	Balimbing	do	
273	*Calocarpum sapota* (Jacq.) Merr.	Chico mamey	do	
239	*Carica papaya* L.	Papaya	do	Native.
241	Do	do	do	Hawaiian, rounded form.
242	Do	do	do	Hawaiian, oblong obovoid form.
94	*Citrullus vulgaris* Schrad.	Sandia, pakuan, watermelon	do	
184	*Citrus limonia* Osbeck	Lemon	do	
102	*Citrus maxima* (Burm.) Merr.	Lukban, pomelo, grape fruit	do	
252	*Citrus mitis* Blanco	Kalamansi, calamondin	do	
123	*Cucumis melo* L.	Melon castila	do	
124	Do	Melon tagalog	do	
863	Do	Cantaloupe	do	Black kinalabasa.
864	Do	do	do	White kinalabasa.
865	Do	do	do	Black baluga.
866	Do	do	do	Black valencia.
867	Do	do	do	Kinastila.
868	Do	do	do	From Imus, Cavite.
287	*Citrus aurantium* L.	Cajel, dalandan	do	

298	*Citrus nobilis* Lour	Naranjita	do	
285	*Cyphomandra calycina* Sondt	Cyndra	do	
188	*Decaspermum fruticosum* Forst	Tambis	do	
234	*Dillenia philipinensis* Rolfe	Catmon	do	
122	*Diospyros discolor* Willd	Mabolo	do	Red fruit.
169	Do	do	do	Yellow fruit.
888	Do	do	do	Seedless.
817	*Diospyros kaki* L	Sapote	do	Imported from China.
115	*Eugenia cumini* (L.) Druce	Duhat	do	
167	*Eugenia javanica* Lam	Makopa	do	
874	*Eugenia malaccensis* L	Tersana	do	
283	*Eugenia polycephaloides* C. B. Rob	Lipoti	do	
190	*Ficus cuernosensis* Elm	Agbay	Pulp and seeds	
187	*Ficus nota* (Blanco) Merr	Tibig	do	
282	*Flacourtia ramontchi* L. Herit	Serali	do	
91	*Fragaria chiloensis* Dch	Strawberry	do	
873	*Garcinia cochinchinensis*	Garcinia	Pulp	
889	*Garcinia dulcis* (Roxb.) Kurz	Taklang-anak, banate	do	
381	*Garcinia mangostana* L	Mangosteen	do	
390	*Garcinia venulosa* (Blanco) Choisy	Gatasan, katuri	do	
284	*Garcinia vidalii* Merr	Piris	do	
189	*Grewia stylocarpa* Warb	Kamuling	do	
824	*Lansium domesticum* Correa	Lanzones	do	
125	*Lichi chinensis* Son	Litchi, lechias, lichi	do	Imported from China.
218	*Mangifera indica* L	Manga, mango	do	Ripe fruit, carabao variety.
219	Do	do	do	Ripe fruit, pico variety.
222	*Musa sapientum* L. var. *cinerea* (Blanco) Teodoro	Latundan	do	
223	*Musa sapientum* L. var. *compressa* (Blanco) Teodoro	Saba	do	
221	*Musa sapientum* L. var. *lacatan* (Blanco) Teodoro	Lacatan	do	
220	*Musa sapientum* L. var. *suaveolens* (Blanco) Teodoro	Bungulan	do	
231	*Musa sapientum* L. var. *ternatensis* (Blanco) Teodoro	Gloria	do	
285	*Musa sapientum* L. var. *violacea* (Blanco) Teodoro	Morado	do	

TABLE 1.—*Names of Philippine food plants analyzed*—Continued.

FRUITS—Continued.

Sample No.	Name of plant.		Part analyzed.	Remarks.
	Scientific.	Common.		
138	*Morus alba* L.	Mulberry	Pulp and seeeds	
114	*Nephelium mutabile* Blanco	Bulala	Pulp	
64	*Passiflora alba*	Passiflora alba	Pulp and seeds	
161	*Passiflora edulis* Sims	Lilikoi, purple-fruited passion flower	do	
65	*Passiflora mollisima* L. H. Bailey	Passiflora mollisima	do	
210	*Psidium guajava* L.	Guava	do	
265	*Persea americana* Mill	Avocado	Flesh	
227	*Punica granatum* L.	Granada	Pulp and seeds	
243	*Pyrus communis* L.	Pear	Pulp	Imported from China.
305	*Pyrus malus* L.	Apple	do	Green-colored fruit; imported from China.
306	Do	do	do	Green-colored fruit; imported from U. S. A.
170	*Sandoricum koetjape* (Burm. f.) Merr	Santol	do	
313	*Spondias lutea* Merr	Mombin	do	
391	*Spondias cytheria* Son	Hevi	do	
116	*Spondias purpurea* L.	Ciruelas, cineguelas	do	
194	*Scindapsus hederaceus* Schott	Putoputuhan	do	
281	*Tamarindus indica* L.	Sampalok, tamarind	do	
121	*Prunus persica* Sieb and Zucc.	Peach	do	Imported from China.
196	*Prunus americana* Marsh.	Plum	do	Imported from U. S. A.
228	*Prunus triflora* Roxb.	do	do	Imported from China.
197	*Prunus* sp.	Sweet cherry	do	
195	*Prunus armeniaca* L.	Common apricot	Pulp and seeds	
275	*Uvaria alba* Merr	Susong calabao	do	
100	*Vaccinium myrtoides* (Bl.) Miq.	Baguio blueberry, gatmo	do	
348	*Zizyphus jujuba* (L.) Lam.	Manzanitas	Pulp	Native.
318	*Zizyphus* sp.	do	do	Imported from China.

SEEDS.

356	*Anacardium occidentale* L.	Kasoy, cashew	Mature seeds	
276	*Arachis hypogaea* L.	Mani, peanut	do	Native variety.
277	Do	do	do	Chinese variety.
247	*Artocarpus integra* (Thunb.) Merr.	Nangka, jack fruit	do	
224	*Barringtonia acutangula* (L.) Gaertn.	Putat	do	
362	*Cajanus cajan* (L.) Millsp.	Kadios	do	
297	*Canarium luzonicum* (Blanco) A. Gray	Pili	do	
514	*Coix lachryma-jobi* L.	Ilas, adlay	do	
249	*Cocos nucifera* L.	Buku	Young nut	
250	Do	Niog, coconut	Mature nut	
251	Do	Macapuno	do	
358	*Glycine max* (L.) Merr.	Soy bean	Mature seeds	
261	Do	Soy bean sprouts	do	
822	*Nymphaea nouchali* Burm. f.	Lauas, tunas	Young seeds	
80	*Pisum sativum* L.	Chicharo, sweet peas	do	
851	*Phaseolus aureus* Roxb.	Mungo, mung bean	Mature seeds	Green-colored seeds.
173	Do	Taogui (mungo sprouts)	Seed sprouts	One day old, radicle and plumule 2 to 3 mm.
174	Do	do	do	Two days old, radicle 10 to 15 mm long.
174-A	Do	do	do	Three to four days old, radicle 20 to 30 mm long.
148	*Phaseolus* sp.	Sheeras bean	Young seeds	
850	Do	Mungo	Mature seeds	Red seeds.
360-A	*Phaseolus lunatus* L.	Patani, cowpea	do	
861	*Phaseolus aureus* Roxb.	Mungo	do	Yellow seeds.
[illegible]	*Oryza sativa* L.	Bigas (rice)	do	Ramai variety.
363-A	Do	Tikitiki	Rice bran	
235	*Zea mays* L.	Maiz, corn	Young seeds	Yellow seeds.
857	Do	do	Mature seeds	Do.
236	Do	do	Young seeds	White seeds.
278	*Vigna sinensis* (L.) Savi	Sitao, balatong	do	
859	*Juglas regia* L.	Nuez, English walnut	Mature nuts	

TABLE 1.—*Names of Philippine food plants analyzed*—Continued.

ROOTS, TUBERS, AND RHIZOMES.

Sample No.	Name of plant.		Part analyzed.	Remarks.
	Scientific.	Common.		
58	*Beta vulgaris* L.	Remolacha, beet	Root	
262	Do.	do.	do.	Chinese beet.
263	Do.	do.	do.	American beet.
101	*Brassica napobrassica* Mill.	Rutabaga	do.	
282	Do.	do.	do.	Imported from U. S. A.
264	*Brassica rapa* L.	Turnip	do.	Baguio turnip, round form.
816	Do.	do.	do.	
86	*Colocasia esculentum* (L.) Schott.	Gabi	Tuber	Native gabi.
807	Do.	do.	do.	Chinese gabi.
213	*Curcuma longa* (L.) Schott.	Dilaw, turmeric	Rhizome	
81	*Daucus carota* (L.)	Carrot	Root	
254	Do.	do.	do.	Chinese carrot.
258	Do.	do.	do.	American carrot.
845	Do.	do.	do.	Japanese carrot.
847	*Dioscorea alata* (L.)	Ube	Tuber	
193	*Dioscorea hispida* Dennst.	Nami	Root	
127	*Eleocharis dulcis* (Burm. f.) Trin.	Apulid, water chestnut	Rhizome	Native variety.
126	*Eleocharis* sp.	Chinese water chestnut	do.	Chinese variety.
154	*Ipomoea batatas* (L.) Poir.	Kamote, sweet potato	Root	White skin, red within.
179	Do.	do.	do.	Red skin, white within.
177	Do.	do.	do.	White skin, yellow within.
176	Do.	do.	do.	Pink skin, yellow within.
178	Do.	do.	do.	White skin, white within.
183	Do.	do.	do.	Baguio sweet potato.
808	Do.	do.	do.	Chinese sweet potato.

87	*Pachyrrhizus erosus* (L.) Urb.	Sincamas	do	
54	*Pastinaca sativa* L.	Parsnip	do	
259	Do	do	do	American variety.
63	*Raphanus sativus* L.	Rabanos, radish	do	
61	Do	do	do	Red-colored skin.
346	Do	do	do	Japanese variety.
69	*Solanum tuberosum* L.	Patatas, potato	Tuber	Japanese potato.
157	Do	do	do	Benguet potato.
214	*Zingiber officinale* Roscoe	Luya, ginger	Rhizome	
310	Do	do	do	Chinese ginger.

TABLE 2.—*Analysis of the ash of plant materials (with and without fusion with sodium carbonate).*

Sample No.	Treatment with or without sodium carbonate.	Phosphorus (P_2O_5).	Calcium (CaO).	Iron (Fe_2O_3).
		Per cent.	*Per cent.*	*Per cent.*
10	Fused	9.56	25.52	0.81
10	Not fused	9.47	25.01	0.72
47–A	Fused	14.42	4.96	1.29
47–A	Not fused	14.08	4.89	1.15
3	Fused	5.58	31.33	0.45
3	Not fused	5.56	30.94	0.43

TABLE 3.—*Phosphoric anhydride in moisture-free samples ashed with and without magnesium nitrate solution.*

Sample No.	Treatment.	Phosphorus (P_2O_5).
		Per cent.
22	With magnesium nitrate	1.76
22	Without magnesium nitrate	1.74
52	With magnesium nitrate	1.19
52	Without magnesium nitrate	1.14

TABLE 4.—*The phosphorus, calcium, and iron contents of leafy vegetables and the corresponding calcium oxide-phosphorus pentoxide ratio of each.*

Sample No.	Common name of plant.	Moisture.	Ash in—		Phosphorus (P_2O_5) in—			Calcium (CaO) in—			Iron (Fe_2O_3) in—			Ratio $CaO:P_2O_5$.
			Fresh sample.	Moisture-free sample.	Fresh sample.	Moisture-free sample.	Ash.	Fresh sample.	Moisture-free sample.	Ash.	Fresh sample.	Moisture-free sample.	Ash.	
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
8	Himbaba-ó	74.00	2.88	11.08	0.38	1.47	13.24	0.41	1.58	14.35	0.030	0.12	1.05	1:0.9
19	Sibuyas	90.15	0.90	9.16	0.10	1.00	10.86	0.16	1.61	17.61	0.011	0.11	1.20	1:0.6
60	Cibol	87.96	1.18	9.73	0.07	0.54	5.56	0.22	1.84	18.92	0.010	0.08	0.82	1:0.8
57	Leek	90.66	0.78	8.31	0.11	1.18	14.19	0.10	1.03	12.35	0.005	0.06	0.67	1:1.1
15	Bauang	91.01	1.24	13.78	0.16	1.83	13.25	0.13	1.43	10.36	0.007	0.08	0.58	1:1.2
18	Kuchai	90.97	1.45	16.09	0.16	1.74	10.81	0.14	1.55	9.61	0.012	0.14	0.86	1:1.1
159	Kudlapa	85.36	2.74	18.69	0.21	1.40	7.47	0.52	3.57	19.10	0.009	0.06	0.32	1:0.4
182	Halon	88.51	2.20	19.18	0.19	1.65	8.59	0.32	2.82	14.71	0.017	0.15	0.77	1:0.6
1	Kolitis	89.13	2.10	19.64	0.21	1.99	10.11	0.39	3.63	18.50	0.045	0.42	2.16	1:0.5
158	Kasoy	74.30	1.10	4.28	0.27	1.03	24.11	0.05	0.18	4.11	0.025	0.10	2.29	1:5.4
9	Kinchai	86.00	2.06	14.71	0.16	1.12	7.61	0.34	2.45	16.63	0.015	0.11	0.74	1:0.5
58	Celery, kinchai puti	94.13	0.84	14.36	0.10	1.74	12.11	0.06	1.09	7.57	0.003	0.05	0.36	1:1.6
20	Pakó	89.98	1.32	13.15	0.26	2.56	19.46	0.03	0.25	1.89	0.006	0.06	0.47	1:10.2
11	Libáto	90.50	1.53	16.08	0.14	1.51	9.37	0.32	3.33	20.68	0.017	0.18	1.09	1:0.5
16	Alibangbang	81.84	1.02	5.63	0.18	1.01	17.96	0.06	0.37	6.50	0.014	0.08	1.37	1:2.7
48	Remolacha	87.91	2.71	22.40	0.15	1.27	5.65	0.38	3.17	14.15	0.035	0.27	1.22	1:0.4
175	Do	96.03	0.83	21.01	0.05	1.28	6.10	0.02	0.52	2.49	0.006	0.14	0.68	1:2.4
314	Swiss chard	91.03	1.82	20.27	0.07	0.73	3.58	0.28	3.14	15.49	0.013	0.15	0.72	1:0.1
10	Petsai	93.63	1.16	18.20	0.11	1.74	9.56	0.30	4.65	25.52	0.009	0.15	0.81	1:0.4
6	Mostaza	91.01	1.43	15.96	0.20	2.22	13.93	0.22	2.47	15.50	0.016	0.18	1.14	1:0.9
237	Do	90.81	1.74	18.94	0.17	1.90	10.05	0.30	3.30	17.42	0.020	0.22	1.17	1:0.6
180	Rutabaga	88.66	1.33	11.77	0.24	2.12	18.04	0.34	2.97	25.27	0.023	0.20	1.69	1:0.7
4	Koles	88.79	1.85	16.54	0.19	1.67	10.07	0.56	5.04	30.47	0.016	0.14	0.87	1:0.3
47	Coliflor	92.24	1.07	13.81	0.16	2.02	14.66	0.08	1.00	7.26	0.003	0.04	0.30	1:2.0
211	Do	90.74	1.07	11.62	0.18	1.95	16.80	0.07	0.71	6.15	0.002	0.03	0.25	1:2.7

TABLE 4.—*The phosphorus, calcium, and iron contents of leafy vegetables and the corresponding calcium oxide-phosphorus pentoxide ratio of each*—Continued.

Sample No.	Common name of plant.	Moisture.	Ash in—		Phosphorus (P_2O_5) in—			Calcium (CaO) in—			Iron (Fe_2O_3) in—			Ratio CaO:P_2O_5.
			Fresh sample.	Moisture-free sample.	Fresh sample.	Moisture-free sample.	Ash.	Fresh sample.	Moisture-free sample.	Ash.	Fresh sample.	Moisture-free sample.	Ash.	
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
25	Repollo	92.09	0.67	8.42	0.08	0.94	11.19	0.07	0.92	10.93	0.002	0.03	0.36	1:1.0
52	Do	92.89	0.74	10.39	0.10	1.42	13.62	0.07	1.01	9.71	0.002	0.03	0.26	1:1.4
319	Brussels sprouts	91.20	0.88	9.96	0.11	1.23	12.34	0.06	0.65	6.49	0.002	0.03	0.25	1:1.9
49	Sprouting broccoli	91.22	1.49	16.76	0.22	2.48	14.62	0.18	1.65	9.87	0.003	0.03	0.19	1:1.8
50	Wongbok	96.80	0.52	16.34	0.08	2.58	15.77	0.04	1.33	8.14	0.001	0.04	0.27	1:1.9
41	Siling labuyo	81.11	2.73	14.45	0.21	1.11	7.71	0.43	2.27	15.69	0.021	0.11	0.76	1:0.5
107	Boboy, kapok	80.02	2.04	10.21	0.23	1.16	11.38	0.41	2.04	20.00	0.013	0.07	0.65	1:0.6
387	Water fern	69.53	4.97	16.31	0.55	1.79	11.10	0.02	0.08	0.48	0.012	0.05	0.24	1:23
344	Tung-hao	93.82	1.12	18.17	0.06	1.02	5.62	0.08	1.27	7.00	0.025	0.41	2.23	1:0.8
55	Escarola	91.56	1.65	19.56	0.10	1.24	6.35	0.16	1.89	9.67	0.008	0.10	0.49	1:0.7
98	Gabi	93.09	1.42	20.58	0.14	2.05	9.95	0.25	3.69	17.92	0.008	0.12	0.57	1:0.6
98-A	Do	93.15	1.64	23.95	0.15	2.15	8.97	0.09	1.29	5.39	0.004	0.06	0.26	1:1.7
98-B	Do	92.70	1.40	19.24	0.12	1.65	8.56	0.10	1.43	7.42	0.006	0.08	0.44	1:1.2
225	Do	78.09	2.96	13.51	0.26	1.19	8.81	0.49	2.22	16.45	0.023	0.10	0.77	1:0.5
43	Saluyot	81.80	2.66	14.61	0.35	1.89	12.97	0.47	2.59	17.74	0.013	0.07	0.50	1:0.7
14	Coriander	86.77	1.41	10.69	0.15	1.16	10.81	0.34	2.56	23.91	0.016	0.12	1.15	1:0.5
35	Calabaza	85.67	2.49	17.34	0.30	2.06	11.90	0.33	2.31	13.32	0.062	0.43	2.50	1:0.9
36	Bago	81.90	1.33	7.33	0.24	1.33	18.18	0.11	0.60	8.12	0.010	0.05	0.74	1:2.2
109	Tukod-langit	85.61	1.51	10.49	0.34	2.33	22.25	0.03	0.24	2.25	0.015	0.10	0.99	1:9.7
29	Kamote	83.96	1.64	10.21	0.15	0.96	9.41	0.13	0.78	7.64	0.020	0.13	1.24	1:1.2
2-A	Kangkong	88.92	1.39	12.59	0.22	1.84	15.89	0.09	0.83	6.55	0.014	0.13	1.00	1:2.2
27	Lechugas	92.98	1.23	17.55	0.11	1.60	9.14	0.19	2.78	15.85	0.020	0.28	1.61	1:0.6
166	Do	96.94	0.49	16.09	0.06	1.90	11.82	0.03	1.12	6.96	0.006	0.19	1.15	1:1.7
329	Tala	88.26	2.10	17.89	0.15	1.25	7.01	0.31	2.65	14.80	0.022	0.10	0.58	1:0.5
320	Kamoteng-kahoi	84.95	1.39	9.35	0.26	1.71	18.46	0.05	0.34	3.65	0.011	0.07	0.77	1:5.0
117	Yerba buena	88.02	1.50	12.51	0.14	1.14	9.13	0.24	2.02	16.11	0.042	0.35	2.78	1:0.6
21	Malagoso	91.65	1.50	17.97	0.10	1.14	6.34	0.11	1.33	7.39	0.030	0.35	1.97	1:0.9

28	Ampalaya	86.48	2.54	18.77	0.19	1.37	7.32	0.59	4.36	23.23	0.064	0.47	2.52	1:0.3
331	Buyok-buyok	81.62	1.38	7.50	0.30	1.62	21.61	0.09	0.46	6.19	0.014	0.07	0.99	1:3.5
40	Malungai	79.19	2.84	13.64	0.24	1.16	8.52	0.72	3.47	25.42	0.108	0.52	3.82	1:0.3
321	Tunas	97.45	0.57	22.17	0.05	1.85	8.34	0.07	0.26	1.16	0.004	0.15	0.67	1:7.0
23	Perejil	82.56	2.77	15.90	0.23	1.29	8.12	0.49	2.79	17.55	0.039	0.23	1.42	1:0.5
335	Kapilan	86.44	1.60	11.50	0.22	1.56	13.53	0.22	1.60	13.88	0.014	0.10	0.86	1:1.0
137	Pokeweed	83.91	2.39	14.87	0.21	1.28	8.60	0.20	1.26	8.47	0.013	0.08	0.55	1:1.0
315	Japanese plantain	86.16	2.09	15.08	0.15	1.07	7.07	0.53	3.86	25.58	0.024	0.17	1.15	1:0.3
333	Ulasiman	93.27	1.60	23.75	0.11	1.67	7.03	0.16	2.31	9.74	0.007	0.10	0.42	1:0.7
51	Water cress	92.30	1.19	15.51	0.16	2.13	13.75	0.14	1.83	11.78	0.015	0.20	1.27	1:1.2
3	Garden rhubarb	90.08	1.78	17.97	0.10	1.00	5.58	0.56	5.63	31.33	0.008	0.08	0.45	1:0.2
59	Indian spinach	88.94	2.75	24.82	0.20	1.82	7.34	0.17	1.49	6.02	0.013	0.12	0.48	1:1.2
182	Chayote	98.06	0.29	14.74	0.06	3.01	20.45	0.02	0.90	6.09	0.002	0.09	0.61	1:3.3
133	Amantec	84.75	1.84	12.08	0.19	1.23	10.15	0.56	3.68	30.45	0.009	0.06	0.48	1:0.3
93	American spinach	91.15	2.41	27.29	0.14	1.62	5.93	0.13	1.47	5.38	0.063	0.72	2.63	1:1.1
56	Prickly-seeded spinach	86.19	3.34	24.21	0.29	2.11	8.70	0.35	2.54	10.51	0.017	0.13	0.52	1:0.8
869	Ciruelas	75.12	1.79	7.20	0.23	0.92	12.73	0.54	2.18	30.21	0.013	0.05	0.73	1:0.4
172	Sampalok	82.80	0.77	4.50	0.21	1.21	26.85	0.04	0.22	4.89	0.004	0.02	0.47	1:5.5
46	New Zealand spinach	91.13	2.52	28.46	0.12	1.54	5.42	0.11	1.41	4.94	0.037	0.47	1.66	1:1.1
119	Toston	89.36	2.66	24.99	0.17	1.60	6.39	0.15	1.38	5.52	0.067	0.63	2.51	1:1.1
332	Sintas-sintasan	92.19	1.12	14.38	0.25	3.15	21.94	0.09	1.21	8.42	0.011	0.15	1.02	1:2.6
39	Sitao	88.08	1.79	15.05	0.27	2.27	15.09	0.28	2.33	15.48	0.014	0.12	0.77	1:1.0

TABLE 5.—*Distribution of leafy vegetables according to the ash, phosphorus, calcium, and iron contents.*[a]

Ash.	Samples analyzed.	Phosphorus pentoxide.	Samples analyzed.	Calcium oxide.	Samples analyzed.	Ferric oxide.	Samples analyzed.
Per cent.		*Per cent.*		*Per cent.*		*Per cent.*	
2.81– 5.00	2	0.54–1.00	7	0.02–0.10	1	0.01–0.10	35
5.01–10.00	10	1.01–1.50	27	0.11–1.00	17	0.11–0.19	23
10.01–15.00	24	1.51–2.00	25	1.01–2.00	24	0.20–0.29	6
15.01–20.00	26	2.01–2.50	11	2.01–3.00	18	0.30–0.39	2
20.01–25.00	10	2.50–3.00	2	3.01–4.00	10	0.40–0.49	5
25.01–28.46	2	3.01–3.15	2	4.01–5.63	4	0.50–0.72	3

[a] Percentages are based on the moisture-free samples.

TABLE 6.—*Phosphorus, calcium, and iron contents of the nonleafy vegetables and the corresponding calcium oxide-phosphorus pentoxide ratio of each.*

Sample No.	Common name of plant.	Moisture.	Ash in—		Phosphorus (P_2O_5) in—			Calcium (CaO) in—			Iron (Fe_2O_3) in—			Ratio CaO:P_2O_5.
			Fresh sample.	Moisture-free sample.	Fresh sample.	Moisture-free sample.	Ash.	Fresh sample.	Moisture-free sample.	Ash.	Fresh sample.	Moisture-free sample.	Ash.	
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
186	Bufiga	91.48	1.23	14.44	0.17	1.94	13.42	0.03	0.39	2.72	0.003	0.04	0.27	1:4.9
201	Kábo-négro	91.73	0.19	2.34	0.01	0.16	6.80	0.02	0.29	12.41	0.001	0.02	0.74	1:0.6
269	Rimas	89.52	0.13	1.27	0.02	0.18	14.35	0.01	0.12	9.24	0.0002	0.002	0.14	1:1.6
135	Espárrago	94.15	0.74	12.57	0.15	2.60	20.70	0.02	0.28	2.21	0.009	0.14	1.15	1:9.4
200	Do	95.36	0.63	13.52	0.11	2.45	18.09	0.01	0.30	2.22	0.002	0.04	0.31	1:8.1
205	Kauayan toto-o	92.10	0.84	10.67	0.17	2.12	19.87	0.03	0.36	3.42	0.002	0.02	0.19	1:5.8
268	Kondol	96.62	0.51	15.05	0.06	1.74	11.59	0.04	1.26	8.35	0.002	0.05	0.35	1:1.4
68	Kohlrabi	93.69	0.96	15.14	0.12	1.92	12.69	0.05	0.80	5.28	0.004	0.06	0.43	1:2.4
325	Marutong	88.94	0.60	5.39	0.08	0.69	12.80	0.06	0.57	10.56	0.003	0.03	0.57	1:1.2
89	Sili	93.74	0.59	9.39	0.09	1.38	14.72	0.03	0.54	5.71	0.006	0.09	0.97	1:2.6
151	Chileng-bundok	90.57	0.77	8.12	0.12	1.25	15.37	0.03	0.35	4.27	0.003	0.04	0.44	1:3.6
215	Papaya	93.65	0.52	8.12	0.08	1.30	15.96	0.07	1.14	14.03	0.002	0.03	0.32	1:1.1
185	Nióg	89.04	1.95	17.80	0.23	2.06	11.59	0.16	1.43	8.04	0.004	0.04	0.20	1:1.4
62	Pepino	96.96	0.48	15.81	0.08	2.73	17.27	0.04	1.21	7.64	0.002	0.06	0.35	1:2.3
212	Do	97.29	0.43	15.71	0.03	1.00	6.36	0.02	0.86	5.48	0.001	0.04	0.24	1:1.2
141	Calabasa	83.48	1.65	9.96	0.18	1.08	10.83	0.07	0.43	4.34	0.009	0.06	0.58	1:2.5
142	Do	93.54	0.89	13.73	0.12	1.78	12.94	0.05	0.82	5.94	0.001	0.02	0.12	1:2.2
143	Do	91.23	1.59	18.15	0.27	3.06	16.88	0.05	0.56	3.07	0.003	0.03	0.19	1:5.5
156	Do	79.35	0.84	4.05	0.11	0.55	13.55	0.03	0.13	3.20	0.002	0.01	0.29	1:4.2
289	Do	91.20	0.62	7.03	0.07	0.85	12.07	0.02	0.22	3.08	0.001	0.01	0.14	1:3.9
290	Do	86.19	1.05	7.61	0.14	1.00	13.15	0.02	0.14	1.81	0.002	0.01	0.17	1:7.3
291	Do	86.21	1.25	9.06	0.15	1.06	11.71	0.06	0.40	4.44	0.002	0.01	0.16	1:2.6
301	Do	79.58	3.41	16.70	0.58	2.86	17.10	0.21	1.05	6.30	0.02	0.12	0.73	1:2.7
70	Do	95.44	0.63	13.82	0.09	2.07	15.00	0.06	1.32	9.55	0.002	0.04	0.26	1:1.6
280	Artichoke	84.78	0.49	2.62	0.09	0.49	18.67	0.01	0.08	2.98	0.001	0.01	0.20	1:6.3

30	Batao	90.02	0.69	6.87	0.12	1.22	17.72	0.05	0.51	7.41	0.003	0.03	0.38	1:2.4
31	Okra	88.99	0.80	7.31	0.14	1.27	17.31	0.09	0.90	12.26	0.002	0.02	0.31	1:1.4
37	Upo	95.89	0.54	13.23	0.03	0.81	6.16	0.05	1.11	8.42	0.003	0.07	0.52	1:0.7
165	Do	97.07	0.38	12.81	0.02	0.70	5.47	0.02	0.54	4.25	0.005	0.18	1.41	1:1.3
129	Do	96.06	0.54	13.73	0.07	1.84	13.38	0.03	0.80	5.80	0.002	0.05	0.38	1:2.3
342	Do	97.67	0.30	13.06	0.07	3.12	23.89	0.03	1.29	9.85	0.001	0.04	0.32	1:2.4
163	Patolang bilog	95.99	0.60	14.89	0.12	2.96	19.90	0.03	0.64	4.32	0.004	0.09	0.62	1:4.6
164	Do	95.36	0.63	13.50	0.11	2.39	17.71	0.04	0.81	6.01	0.003	0.06	0.41	1:2.9
83	Kamates	94.62	0.57	10.54	0.05	0.94	8.91	0.01	0.31	2.91	0.003	0.06	0.54	1:3.1
152	Do	93.41	0.70	10.56	0.11	1.61	15.27	0.03	0.50	4.69	0.005	0.07	0.68	1:3.3
229	Do	94.81	0.54	10.36	0.08	1.47	14.19	0.01	0.12	1.19	0.002	0.03	0.32	1:11.9
12	Ampalaya	94.56	0.64	11.74	0.08	1.38	11.78	0.02	0.39	3.36	0.002	0.04	0.32	1:3.5
181	Malungai	90.31	1.40	14.45	0.19	1.93	13.33	0.01	0.14	0.94	0.005	0.05	0.38	1:14.1
202	Butuan	92.35	1.10	14.35	0.15	1.95	13.58	0.04	0.48	3.32	0.005	0.07	0.49	1:4.1
204	Saba	92.49	1.27	16.93	0.15	2.02	11.92	0.03	0.40	2.34	0.004	0.05	0.31	1:5.1
323	Tunas	84.30	0.95	6.03	0.24	1.50	24.80	0.06	0.86	6.00	0.004	0.03	0.43	1:4.1
327	Sincamas	88.21	0.84	7.10	0.12	1.01	14.27	0.11	0.95	13.37	0.004	0.03	0.48	1:1.1
85	Granadilla	91.91	0.46	5.70	0.04	0.53	9.26	0.04	0.45	7.92	0.003	0.04	0.76	1:1.2
26	Habichuelas	91.94	0.51	6.31	0.10	1.21	19.25	0.06	0.73	11.77	0.002	0.02	0.86	1:1.6
42	String beans	90.93	0.66	7.24	0.12	1.34	18.51	0.09	1.01	13.96	0.004	0.04	0.60	1:1.3
337	Dwarf wax beans	92.07	0.67	8.42	0.16	2.01	23.93	0.08	1.01	12.05	0.003	0.04	0.50	1:2.0
339	Wonder beans	86.94	1.38	10.53	0.25	1.91	18.16	0.12	0.92	8.74	0.009	0.08	0.72	1:2.0
78	Wax beans	92.94	0.92	13.08	0.10	1.40	10.74	0.09	1.28	9.71	0.008	0.11	0.86	1:1.1
146	Bush wax beans	92.89	0.50	7.10	0.12	1.65	23.24	0.06	0.90	12.72	0.006	0.08	1.14	1:1.8
147	Sheeras beans	89.66	0.80	7.70	0.18	1.69	21.90	0.13	1.29	16.75	0.005	0.05	0.68	1:1.3
22	Chicaro	80.74	1.16	6.02	0.31	1.62	26.87	0.12	0.61	10.12	0.006	0.03	0.51	1:2.7
34	Do	80.72	1.10	5.69	0.26	1.35	23.73	0.17	0.87	15.33	0.005	0.03	0.49	1:1.5
74	Chinese peas	87.60	0.84	6.81	0.20	1.59	23.42	0.15	1.23	18.06	0.005	0.04	0.59	1:1.3
336	Cigarillas, seguidillas	75.92	1.86	7.74	0.06	0.24	3.13	0.33	1.37	17.66	0.017	0.07	0.92	1:0.2
71	Chayote	95.06	0.30	6.00	0.04	0.80	13.38	0.35	0.70	11.69	0.001	0.02	0.33	1:1.1
343	Katuray	94.49	0.29	5.23	0.05	0.84	16.13	0.18	0.33	6.28	0.008	0.14	2.68	1:2.6
82	Talong	92.87	0.57	8.05	0.10	1.34	16.68	0.02	0.29	3.62	0.002	0.03	0.41	1:4.6
88	Do	94.19	0.55	9.42	0.07	1.22	12.94	0.03	0.48	5.14	0.002	0.04	0.37	1:2.5
257	Do	94.73	0.54	10.27	0.09	1.62	15.78	0.01	0.22	2.19	0.001	0.02	0.23	1:7.2
82	Do	92.80	0.71	9.82	0.09	1.21	12.37	0.05	0.63	6.41	0.003	0.04	0.45	1:1.9
279	Sampalok	68.97	1.40	4.52	0.16	0.53	11.77	0.32	1.03	22.81	0.004	0.01	0.82	1:0.5

TABLE 6.—*Phosphorus, calcium, and iron contents of the nonleafy vegetables and the corresponding calcium oxide-phosphorus pentoxide ratio of each*—Continued.

Sample No.	Common name of plant.	Moisture.	Ash in—		Phosphorus (P_2O_5) in—			Calcium (CaO) in—			Iron (Fe_2O_3) in—			Ratio CaO:P_2O_5.
			Fresh sample.	Moisture-free sample.	Fresh sample.	Moisture-free sample.	Ash.	Fresh sample.	Moisture-free sample.	Ash.	Fresh sample.	Moisture-free sample.	As .	
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
118	Sampaloc	83.25	0.69	4.14	0.12	0.75	18.04	0.03	0.20	4.95	0.008	0.05	1.21	1:3.6
17	Sitao puti	86.24	1.08	7.85	0.20	1.47	18.76	0.12	0.84	10.74	0.006	0.04	0.53	1:1.7
45	Sitao pula	88.33	0.95	8.10	0.22	1.84	22.73	0.09	0.76	9.39	0.003	0.03	0.32	1:2.4
270	Paayap	89.47	0.87	8.28	0.20	1.91	23.02	0.12	1.17	14.13	0.003	0.03	0.33	1:1.6
271	Bagbagcong	90.33	1.49	15.40	0.28	2.93	19.02	0.14	1.47	9.57	0.004	0.04	0.29	1:1.9
246	Shallot	78.54	0.60	2.81	0.14	0.63	22.50	0.02	0.08	2.70	0.002	0.01	0.40	1:7.8
245	Sibuyas, onion	92.50	0.37	4.93	0.08	1.12	22.63	0.03	0.34	6.83	0.002	0.02	0.46	1:3.3
248	Garlic, bauang, ajo	64.39	1.19	3.35	0.31	0.86	25.80	0.01	0.02	0.43	0.002	0.01	0.14	1:43

TABLE 7.—*Distribution of nonleafy vegetables according to the ash, phosphorus, calcium, and iron contents.*[a]

Ash.	Samples analyzed.	Phosphorus pentoxide.	Samples analyzed.	Calcium oxide.	Samples analyzed.	Ferric oxide.	Samples analyzed.
Per cent.		*Per cent.*		*Per cent.*		*Per cent.*	
1.25– 5.00	9	0.16–0.50	4	0.08–0.25	11	0.01–0.02	17
5.01–10.00	30	0.51–1.50	36	0.26–0.75	29	0.03–0.05	34
10.01–15.00	21	1.51–2.50	23	0.76–1.25	21	0.06–0.08	11
15.01–18.15	9	2.51–3.50	6	1.26–1.47	8	0.09–0.14	7

[a] Percentages are based on the moisture-free samples.

TABLE 8.—*Phosphorus, calcium, and iron contents of fruits, and the corresponding calcium oxide-phosphorus pentoxide ratio of each.*

Sample No.	Common name of plant.	Moisture.	Ash in—		Phosphorus (P_2O_5) in—			Calcium (CaO) in—			Iron (Fe_2O_3) in—			Ratio CaO:P_2O_5.
			Fresh sample.	Moisture-free sample.	Fresh sample.	Moisture-free sample.	Ash.	Fresh sample.	Moisture-free sample.	Ash.	Fresh sample.	Moisture-free sample.	Ash.	
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
208	Chico	75.45	0.39	1.57	0.03	0.11	7.25	0.03	0.12	7.79	0.004	0.02	1.05	1:0.9
206	Piña	89.96	0.42	4.15	0.02	0.17	4.02	0.02	0.24	4.68	0.004	0.04	0.90	1:0.9
240	Do	89.89	0.40	3.56	0.02	0.21	5.88	0.03	0.31	8.73	0.002	0.01	0.39	1:0.7
155	Do	89.43	0.39	3.68	0.02	0.22	6.09	0.01	0.14	3.77	0.004	0.03	0.91	1:1.6
128	Mamon	89.07	0.72	6.60	0.10	0.87	13.17	0.04	0.38	5.76	0.002	0.02	0.29	1:2.3
238	Guayabano	86.26	0.61	4.46	0.05	0.38	8.63	0.01	0.04	0.93	0.001	0.01	0.25	1:9.2
172	Ates	74.77	0.81	3.21	0.13	0.53	16.50	0.05	0.18	5.69	0.002	0.01	0.28	1:2.8
207	Bignai	91.11	0.57	6.41	0.04	0.50	7.84	0.12	1.34	20.94	0.001	0.01	0.21	1:0.4
244	Nangka	72.72	0.96	3.52	0.07	0.24	6.84	0.03	0.12	3.37	0.001	0.002	0.06	1:2.0
199	Kamias	94.82	0.36	6.98	0.04	0.82	11.75	0.009	0.17	2.37	0.002	0.04	0.54	1:5.0
168	Balimbing	93.35	0.46	6.97	0.05	0.70	10.09	0.004	0.07	0.96	0.002	0.04	0.58	1:10.5
275	Chico mamey	75.04	0.91	3.65	0.06	0.25	6.94	0.02	0.08	2.32	0.001	0.05	0.15	1:3.0
239	Papaya	93.23	0.74	10.99	0.03	0.40	3.67	0.03	0.46	4.15	0.002	0.03	0.28	1:0.9
241	Do	90.19	0.37	3.75	0.03	0.29	7.67	0.01	0.11	2.91	0.001	0.01	0.35	1:2.6
242	Do	92.11	0.54	6.84	0.04	0.45	6.51	0.03	0.37	5.46	0.009	0.01	0.18	1:1.2
94	Sandia	94.49	0.43	7.89	0.04	0.82	10.39	0.02	0.30	3.92	0.002	0.04	0.55	1:2.6
184	Lemon	94.81	0.44	8.56	0.06	1.17	13.63	0.04	0.74	8.60	0.003	0.06	0.64	1:1.5
102	Lukban	87.88	0.55	4.57	0.08	0.66	14.43	0.04	0.37	8.13	0.004	0.03	0.68	1:1.7
252	Kalamondin, kalamansi	87.08	0.64	4.99	0.07	0.56	11.41	0.14	1.06	21.31	0.003	0.02	0.43	1:0.5
123	Melon castila	95.54	0.64	14.42	0.03	0.68	4.69	0.04	0.91	6.34	0.002	0.04	0.29	1:0.7
124	Melon tagalog	94.83	1.03	19.89	0.06	1.24	6.24	0.06	1.18	5.92	0.01	0.21	0.56	1:1.1
363	Cantaloupe	95.86	0.50	12.19	0.05	1.24	10.20	0.03	0.73	6.02	0.001	0.03	0.23	1:1.7
364	Do	95.72	0.55	12.88	0.05	1.25	9.71	0.02	0.55	4.26	0.001	0.03	0.21	1:2.3
365	Do	95.39	0.53	11.48	0.03	0.66	5.76	0.03	0.63	5.53	0.001	0.02	0.17	1:1.0
366	Do	93.84	0.84	13.58	0.06	1.00	7.38	0.02	0.36	2.62	0.002	0.02	0.18	1:2.8

2955°—17——4

TABLE 8.—*Phosphorus, calcium, and iron contents of f ruits, and the corresponding calcium oxide-phosphorus pentoxide ratio of each*—Continued.

Sample No.	Common name of plant.	Moisture.	Ash in—		Phosphorus (P_2O_5) in—			Calcium (CaO) in—			Iron (Fe_2O_3) in—			Ratio CaO:P_2O_5.
			Fresh sample.	Moisture-free sample.	Fresh sample.	Moisture-free sample.	Ash.	Fresh sample.	Moisture-free sample.	Ash.	Fresh sample	Moisture-free sample.	Ash.	
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cedt.*	
867	Cantaloupe	93.80	0.62	10.06	0.04	0.69	6.85	0.02	0.28	2.81	0.002	0.03	0.31	1:2.4
868	Do	91.25	0.81	9.24	0.06	0.73	7.85	0.01	0.17	1.85	0.003	0.03	0.33	1:4.2
287	Cajel	91.69	0.43	5.23	0.06	0.70	13.45	0.01	0.17	3.30	0.002	0.03	0.52	1:4.1
298	Naranjita	91.89	0.29	3.62	0.04	0.46	12.81	0.02	0.20	5.45	0.0006	0.01	0.22	1:2.4
286	Cyndra	86.73	0.65	4.87	0.13	0.99	20.39	0.01	0.08	1.71	0.002	0.01	0.27	1:11.9
188	Tambis	94.42	0.29	5.19	0.03	0.47	9.04	0.01	0.20	3.80	0.004	0.06	1.26	1:2.3
284	Catmon	90.17	0.69	6.97	0.06	0.58	8.36	0.06	0.58	8.30	0.003	0.03	0.41	1:1.0
122	Mabolo	84.26	0.64	4.04	0.08	0.48	11.84	0.07	0.48	11.89	0.005	0.03	0.78	1:1.0
169	Do	84.43	0.72	4.64	0.06	0.38	8.27	0.04	0.25	5.44	0.001	0.01	0.11	1:1.5
388	Do	73.62	0.58	2.18	0.05	0.18	8.26	0.05	0.20	8.96	0.001	0.005	0.25	1:0.9
317	Sapote	80.06	0.42	2.12	0.04	0.21	10.11	0.02	0.08	3.63	0.001	0.005	0.24	1:2.8
115	Duhat	85.44	0.70	4.78	0.07	0.48	10.12	0.04	0.27	5.61	0.005	0.03	0.71	1:1.8
167	Makopa	92.96	0.21	2.94	0.03	0.41	13.95	0.01	0.14	4.87	0.001	0.01	0.40	1:2.8
374	Ternana	92.39	0.34	4.47	0.03	0.37	8.37	0.03	0.34	7.71	0.004	0.05	1.06	1:1.1
283	Maigang	88.73	0.53	4.70	0.03	0.28	5.93	0.07	0.58	12.29	0.006	0.05	1.04	1:0.5
190	Agbay	82.59	1.19	8.26	0.09	0.66	7.95	0.01	1.16	14.10	0.002	0.01	0.18	1:0.6
187	Tibig	92.08	1.27	16.05	0.03	0.47	6.26	0.04	3.46	21.54	0.006	0.08	0.48	1:0.3
282	Serali	80.81	0.87	4.54	0.06	0.30	6.50	0.09	0.48	10.50	0.001	0.01	0.15	1:0.6
91	Strawberry	90.86	0.81	8.82	0.08	0.84	9.52	0.05	0.57	6.50	0.001	0.01	0.14	1:1.5
373	Garcinia	86.13	0.42	3.04	0.03	0.25	8.14	0.02	0.14	4.69	0.001	0.01	0.23	1:1.7
389	Taklang-anak	88.28	0.45	3.88	0.04	0.37	9.66	0.01	0.10	2.66	0.009	0.01	0.21	1:3.6
381	Mangosteen	81.89	0.19	1.04	0.05	0.25	24.45	0.01	0.05	5.19	0.002	0.01	0.81	1:4.7
390	Gatasan	88.78	0.35	3.08	0.03	0.29	9.31	0.02	0.14	4.39	0.001	0.01	0.42	1:2.1
284	Piris	90.47	0.29	3.07	0.02	0.20	6.42	0.01	0.16	5.16	0.005	0.05	1.56	1:1.2
189	Ramuling	77.50	1.04	4.63	0.09	0.39	8.61	0.09	0.40	8.74	0.005	0.02	0.49	1:1.0
324	Lanzones	84.47	0.50	3.24	0.07	0.42	13.03	0.01	0.07	2.10	0.007	0.004	0.13	1:6.2

125	Litchi	87.41	0.53	4.18	0.10	0.79	18.89	0.02	0.18	4.31	0.002	0.02	0.42	1:4.3
218	Manga	86.74	0.38	2.90	0.05	0.48	16.39	0.01	0.05	1.89	0.001	0.01	0.42	1:8.6
219	Do	87.16	0.29	2.29	0.04	0.38	16.58	0.01	0.05	2.14	0.001	0.01	0.59	1:7.7
209	Do	85.34	0.33	2.25	0.04	0.27	12.18	0.008	0.05	2.41	0.003	0.02	0.98	1:5.1
222	Latundan	78.63	0.65	3.04	0.07	0.35	11.63	0.02	0.02	0.70	0.002	0.01	0.34	1:16.0
223	Saba	74.69	0.61	2.41	0.07	0.28	11.71	0.01	0.03	1.20	0.002	0.01	0.35	1:9.7
221	Lacatan	76.10	0.63	2.62	0.06	0.26	10.05	0.02	0.02	0.90	0.001	0.04	0.17	1:11.1
220	Bungulan	74.68	0.78	3.07	0.04	0.17	5.47	0.01	0.02	0.58	0.001	0.01	0.18	1:9.4
231	Gloria	63.93	1.10	3.06	0.07	0.20	6.68	0.001	0.003	0.11	0.002	0.004	0.14	1:60.7
285	Morado	76.43	0.81	3.43	0.06	0.25	7.20	0.009	0.04	1.12	0.001	0.004	0.12	1:6.4
138	Mulberry	87.69	0.98	7.95	0.14	1.11	13.93	0.17	1.41	17.70	0.004	0.04	0.45	1:0.8
114	Bulala	90.87	0.43	4.66	0.05	0.56	11.95	0.01	0.05	1.07	0.002	0.03	0.54	1:11.1
64	Passiflora alba	73.60	1.18	4.47	0.25	0.94	21.09	0.02	0.09	2.04	0.007	0.03	0.56	1:10.8
161	Lilikoi	73.86	0.86	3.24	0.17	0.63	19.37	0.03	0.10	2.99	0.006	0.02	0.74	1:6.4
65	Passiflora mollisima	87.69	0.73	5.90	0.09	0.74	12.59	0.02	0.17	2.84	0.001	0.01	0.20	1:4.4
210	Guava	81.82	0.66	3.61	0.10	0.57	15.90	0.02	0.11	3.02	0.003	0.02	0.49	1:5.3
265	Avocado	82.61	0.85	4.85	0.12	0.67	13.70	0.01	0.05	0.94	0.003	0.02	0.37	1:14.5
227	Granada	77.81	0.85	3.82	0.15	0.69	17.95	0.01	0.03	0.86	0.006	0.03	0.80	1:20.8
243	Pears	90.65	0.23	2.46	0.02	0.24	9.70	0.006	0.07	2.66	0.002	0.02	0.72	1:3.6
305	Apples	85.03	0.37	2.47	0.04	0.25	10.09	0.005	0.03	1.41	0.001	0.01	0.35	1:7.2
306	Do	85.72	0.33	2.30	0.04	0.26	11.19	0.004	0.03	1.36	0.001	0.01	0.40	1:8.2
170	Santol	85.50	0.65	4.45	0.03	0.20	4.47	0.01	0.06	1.45	0.002	0.01	0.26	1:3.1
313	Mombin	85.82	0.80	5.65	0.13	0.91	16.06	0.01	0.07	1.32	0.007	0.05	0.90	1:12.2
391	Hevi	84.65	0.49	3.19	0.06	0.38	11.84	0.03	0.22	6.96	0.003	0.02	0.52	1:1.7
116	Ciruelas	85.44	0.57	3.93	0.11	0.78	19.78	0.01	0.08	2.15	0.003	0.02	0.61	1:9.2
194	Putoputohan	76.32	1.61	6.78	0.25	1.03	15.22	0.15	0.62	9.19	0.002	0.01	0.18	1:1.7
281	Sampaloc	85.88	3.93	6.08	0.34	0.53	8.70	0.13	0.20	3.22	0.002	0.02	0.40	1:2.7
121	Peach	88.74	0.55	4.88	0.05	0.45	9.25	0.01	0.07	1.38	0.002	0.03	0.43	1:6.7
196	Plums	89.69	0.38	3.71	0.07	0.64	17.32	0.01	0.08	2.21	0.002	0.03	0.41	1:7.8
238	Do	88.54	0.32	2.76	0.03	0.26	9.26	0.01	0.07	2.62	0.002	0.02	0.63	1:3.5
197	Sweet cherries	83.74	0.62	3.82	0.08	0.51	13.34	0.02	0.13	3.43	0.003	0.02	0.56	1:3.8
195	Apricot	88.72	0.83	7.38	0.12	1.10	14.90	0.04	0.34	4.56	0.003	0.02	0.33	1:3.2
275	Susong calabao	78.32	1.22	5.63	0.10	0.48	8.41	0.03	0.15	2.63	0.010	0.06	1.07	1:3.2
100	Baguio blueberry	79.75	0.41	2.04	0.05	0.23	11.45	0.06	0.30	14.72	0.007	0.04	1.81	1:0.8
348	Manzanitas	79.10	0.80	3.81	0.07	0.32	8.53	0.04	0.18	4.68	0.003	0.01	0.53	1:1.8
318	Do	85.52	0.39	2.78	0.03	0.17	6.24	0.03	0.20	7.31	0.003	0.02	0.79	1:0.9

TABLE 9.—*Distribution of edible fruits according to the ash, phosphorus, calcium, and iron contents.*[a]

Ash.	Samples analyzed.	Phosphorus pentoxide.	Samples analyzed.	Calcium oxide.	Samples analyzed.	Ferric oxide.	Samples analyzed.
Per cent.		*Per cent.*		*Per cent.*		*Per cent.*	
1.57– 4.99	58	0.11–0.30	28	0.02–0.09	29	0.002–0.004	4
5.19– 9.24	20	0.31 0.60	29	0.10–0.50	43	0.01 –0.03	65
10.06–15.00	7	0.61–0.99	22	0.51–1.00	9	0.04 –0.07	14
15.01–19.89	2	1.00–1.25	8	1.01–3.46	6	0.08 –0.21	2

[a] Percentages are based on the moisture-free samples.

TABLE 10.—*Phosphorus, calcium, and iron contents of seeds and the corresponding calcium oxide-phosphorus pentoxide ratio of each.*

Sample No.	Common name of plant.	Moisture.	Ash in—		Phosphorus (P_2O_5) in—			Calcium (CaO) in—			Iron (Fe_2O_3) in—			Ratio CaO:P_2O_5.
			Sample analyzed.	Moisture-free sample.	Fresh sample.	Moisture-free sample.	Ash.	Sample analyzed.	Moisture-free sample.	Ash.	Sample analyzed.	Moisture-free sample.	Ash.	
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
356	Kasoy	9.02	2.49	2.74	1.12	1.23	44.89	0.04	0.04	1.46	0.009	0.010	0.37	1:30.7
276	Mani	10.98	2.33	2.62	1.02	1.15	43.89	0.29	0.33	12.59	0.002	0.003	0.11	1:3.5
277	Do	36.53	1.91	3.01	0.72	1.13	37.54	0.13	0.20	6.64	0.002	0.004	0.13	1:5.7
247	Nangka	57.77	1.25	2.96	0.23	0.54	18.24	0.06	0.13	4.39	0.002	0.005	0.17	1:4.2
224	Putat	95.42	0.15	3.38	0.03	0.77	22.79	0.001	0.02	0.69	0.001	0.009	0.26	1:33
362	Kadios	15.13	3.01	3.55	0.77	0.91	25.63	0.33	0.39	10.98	0.012	0.018	0.37	1:2.3
297	Pili	47.62	1.73	3.30	0.87	1.66	50.30	0.14	0.27	8.18	0.003	0.006	0.18	1:6.1
514	Ilas	10.47	2.08	2.32	0.88	0.98	42.09	0.04	0.05	2.06	0.012	0.013	0.58	1:21
249	Niog	77.03	1.06	4.61	0.19	0.82	17.68	0.01	0.06	1.23	0.003	0.014	0.30	1:14.4
250	Do	68.85	0.53	1.70	0.16	0.50	29.51	0.004	0.01	0.69	0.002	0.005	0.32	1:42.8

251	Do	74.41	0.58	2.26	0.15	0.57	25.43	0.01	0.03	1.53	0.001	0.005	0.23	1:16.6
858	Soy bean	6.58	4.68	5.01	1.06	1.14	22.75	0.24	0.26	5.19	0.018	0.019	0.38	1:3.4
261	Soy bean sprouts	80.65	1.01	5.21	0.29	1.52	29.11	0.06	0.30	5.76	0.003	0.014	0.26	1:5.1
822	Lauas	64.09	0.42	1.17	0.12	0.33	28.24	0.01	0.03	2.79	0.001	0.004	0.32	1:10.1
80	Chicharo	81.30	0.82	4.40	0.32	1.69	38.45	0.02	0.08	1.83	0.004	0.024	0.54	1:21
851	Mungo	13.05	2.98	3.43	0.78	0.90	26.23	0.14	0.16	4.66	0.014	0.016	0.47	1:5.6
173	Togue	88.53	0 53	4.63	0.17	1.47	31.75	0.01	0.04	0.96	0.003	0.029	0.63	1:33
174	Do	70.94	1.95	6.71	0.57	1.97	29.40	0.03	0.12	1.79	0.007	0.025	0.38	1:16.4
174-A	Do	80.15	1.01	5.07	0.22	1.09	21.56	0.02	0.12	2.40	0.004	0.020	0.40	1.9
148	Sheeras beans	59.73	1.90	4.71	0.67	1.66	35.29	0.16	0.40	8.42	0.014	0.034	0.72	1:4.2
850	Mungo	12.32	2.77	3.16	0.81	0.92	29.11	0.14	0.16	5.06	0.012	0.014	0.44	1:5.8
860	Patani	59.66	1.82	4.52	0.34	0.85	18.80	0.03	0.08	1.76	0.004	0.010	0.22	1:10.7
860-A	Do	57.43	2.01	4.71	0.44	1.02	21.65	0.01	0.02	0.42	0.005	0.011	0.23	1:51.5
861	Mungo	9.15	3.79	4.17	0.93	1.02	24.46	0.42	0.47	11.27	0.009	0.010	0.24	1:2
863	Bigas	11 03	0.87	0.98	0.60	0.68	69.38	0.018	0.02	2.04	0.002	0 002	0.20	1:34.7
863-A	Tikitikl	15.87	9.06	10.77	4.68	5.66	52.61	0.009	0.017	0.10	0.022	0.026	0.24	1:52.6
863	Sesame	5.98	6.23	6.63	1.73	1.84	27.75	0.66	0.70	10.57	0.007	0.008	0.12	1:2.6
235	Maiz	90.17	0.13	1.35	0.08	0.85	62.96	0.002	0.17	12.59	0.001	0.005	0.37	1:5
857	Do	11.64	1.29	1.46	0.57	0.65	44.52	0.07	0.08	5.48	0.006	0.007	0.48	1:13.4
286	Do	67.04	0.39	1.18	0.11	0.35	29.43	0.005	0.014	1.19	0.001	0.002	0.21	1:24.7
278	Sitao	59.73	1.90	4.71	0.67	1.66	35.29	0.16	0.40	8.42	0.014	0.034	0.72	1:4.2
859	Nuez	5.56	1.80	1.91	0.78	0.83	43.45	0.149	0.15	7.85	0.004	0.004	0.21	1:5.5

TABLE 11.—*Distribution of edible seeds according to the ash, phosphorus, calcium, and iron contents.*[a]

Ash.	Samples analyzed.	Phosphorus pentoxide.	Samples analyzed.	Calcium oxide.	Samples analyzed.	Ferric oxide.	Samples analyzed.
Per cent.		*Per cent.*		*Per cent.*		*Per cent.*	
0.98–2.50	8	0.35–0.75	7	0.01–0.09	13	0.002–0.005	11
2.51–4.50	12	0.76–1.25	15	0.10–0.39	10	0.006–0.009	4
4.51–6.62	8	1.26–5.66	6	0.40–0.70	5	0.01 –0.080	13

[a] Percentages are based on the moisture-free samples.

TABLE 12.—*Phosphorus, calcium, and iron contents of roots, rhizomes, and tubers and the corresponding calcium oxide-phosphorus pentoxide ratio of each.*

Sample No.	Common name of plant.	Moisture.	Ash in—		Phosphorus (P_2O_5) in—			Calcium (CaO) in—			Iron (Fe_2O_3) in—			Ratio CaO:P_2O_5.
			Sample analyzed.	Moisture-free sample.	Sample analyzed.	Moisture-free sample.	Ash.	Sample analyzed.	Moisture-free sample.	Ash.	Sample analyzed.	Moisture-free sample.	Ash.	
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
[illegible]	Remolacha	90.26	1.32	13.58	0.11	1.42	8.41	0.02	0.16	1.18	0.003	0.03	0.23	1:7
262	Beet	89.20	0.82	7.61	0.12	1.07	14.02	0.01	0.15	1.77	0.004	0.04	0.49	1:7.9
263	Do	86.92	1.93	14.73	0.18	1.41	9.58	0.02	0.17	1.17	0.004	0.03	0.21	1:8.2
101	Rutabaga	91.63	1.05	12.58	0.15	1.78	14.12	0.09	1.12	8.93	0.007	0.08	0.66	1:1.6
232	Do	90.38	0.52	5.45	0.08	0.88	16.17	0.04	0.40	7.28	0.003	0.03	0.56	1:2.2
264	Turnip	94.79	0.58	11.04	0.07	1.29	11.72	0.04	0.85	7.69	0.002	0.03	0.29	1:1.5
816	Do	93.40	0.62	9.37	0.08	1.25	13.34	0.06	0.92	9.78	0.001	0.02	0.17	1:1.4
86	Gabi	65.29	1.26	3.63	0.18	0.52	14.26	0.11	0.30	8.36	0.003	0.01	0.24	1:1.7
807	Do	63.76	0.72	1.99	0.14	0.38	19.27	0.03	0.09	4.36	0.001	0.003	0.16	1:4.4
213	Dilau	86.90	1.21	9.26	0.17	1.33	14.32	0.02	0.13	1.89	0.008	0.06	0.66	1:10.3
81	Carrot	89.07	1.25	11.41	0.08	0.74	6.50	0.07	0.66	5.81	0.008	0.07	0.62	1:1.1
254	Do	88.06	1.45	12.18	0.22	1.82	14.96	0.07	0.55	4.51	0.003	0.03	0.21	1:3.3
258	Do	92.04	0.75	9.39	0.06	0.78	8.33	0.05	0.60	6.44	0.003	0.04	0.38	1:1.3
345	Do	91.30	0.62	7.12	0.07	0.77	10.87	0.03	0.34	4.83	0.001	0.02	0.24	1:2.3
347	Ubi	69.84	0.73	2.43	0.12	0.38	15.83	0.002	0.01	0.31	0.003	0.01	0.45	1:51
193	Nami	90.93	0.71	7.87	0.09	1.02	12.93	0.07	0.75	9.58	0.003	0.04	0.48	1:1.3
127	Apulid	41.82	1.10	1.89	0.34	0.58	30.60	0.02	0.03	1.43	0.003	0.01	0.26	1:21.3
126	Chinese water chestnut	79.99	1.17	5.83	0.21	1.05	17.96	0.005	0.03	0.46	0.006	0.03	0.52	1:0.4
154	Camote	68.37	0.67	2.12	0.12	0.38	18.14	0.03	0.08	4.09	0.003	0.01	0.41	1:4.4
179	Do	72.71	0.60	2.19	0.08	0.30	13.77	0.02	0.09	3.90	0.001	0.01	0.21	1:3.5
177	Do	64.86	1.07	3.04	0.12	0.35	11.45	0.05	0.13	4.38	0.008	0.02	0.77	1:2.6
176	Do	67.78	1.15	3.57	0.16	0.49	13.78	0.03	0.10	2.70	0.002	0.01	0.21	1:5.1
178	Do	62.46	0.98	2.62	0.13	0.35	13.30	0.05	0.14	5.19	0.002	0.01	0.19	1:2.6
183	Do	73.72	0.97	3.70	0.13	0.50	13.46	0.03	0.10	2.81	0.002	0.01	0.25	1:4.8
308	Do	63.20	1.26	3.42	0.14	0.38	11.11	0.02	0.06	1.80	0.002	0.01	0.19	1:6.2

87	Sincamas	90.32	0.40	4.15	0.04	0.45	10.85	0.04	.39	9.33	0.003	0.03	0.65	1:1.2
54	Parsnip	72.20	1.97	6.61	0.22	0.85	12.92	0.10	0.35	5.22	0.005	0.02	0.24	1:2.5
259	Do	82.21	1.19	6.69	0.22	1.22	18.18	0.07	0.38	5.63	0.006	0.03	0.47	1:3.2
63	Radish	94.14	1.08	18.49	0.10	1.73	9.35	0.07	1.22	6.61	0.006	0.11	0.60	1:1.4
61	Rabanos	91.05	1.32	14.77	0.12	1.37	9.27	0.07	0.78	5.31	0.007	0.08	0.59	1:1.7
346	Do	94.94	0.62	12.22	0.64	1.26	10.30	0.02	0.46	3.78	0.003	0.05	0.42	1:2.7
69	Patatas	79.81	0.91	4.51	0.12	0.60	13.20	0.02	0.08	1.68	0.006	0.03	0.64	1:7.8
157	Do	84.38	0.68	4.34	0.12	0.79	18.26	0.01	0.08	1.80	0.003	0.02	0.42	1:10.1
214	Luya	80.60	1.39	7.14	0.15	0.78	10.90	0.02	0.09	1.29	0.006	0.03	0.41	1:8.4
310	Do	92.55	0.68	9.13	0.04	0.57	6.29	0.03	0.39	4.28	0.004	0.05	0.58	1:1.5

TABLE 13.—*Distribution of roots, rhizomes, and tubers according to the ash, phosphorus, calcium, and iron contents.*[a]

Ash.	Samples analyzed.	Phosphorus pentoxide.	Samples analyzed.	Calcium oxide.	Samples analyzed.	Ferric oxide.	Samples analyzed.
Per cent.		*Per cent.*		*Per cent.*		*Per cent.*	
1.99– 3.00	6	0.35–0.75	15	0.01–0.09	10	0.003–0.01	10
3.01– 6.00	9	0.76–1.25	11	0.10–0.50	16	0.02–0.04	18
6.01–12.00	13	1.26–1.50	6	0.51–1.00	7	0.05–0.07	4
12.01–18.49	7	1.51–1.73	3	1.01–1.22	2	0.08–0.11	3

[a] Percentages are based on the moisture-free samples.

TABLE 14.—*Some common Philippine food plants that serve as excellent sources for phosphorus, calcium, or iron.*

[Percentages are based on moisture-free samples.]

Sample No.	Name of plant.	Part used.	Phosphorus (P_2O_5).	Calcium (CaO).	Iron (Fe_2O_3).
			Per cent.	*Per cent.*	*Per cent.*
28	Ampalaya (*Momordica charantia*)	Leaves		4.86	0.47
202	Saba (*Musa sapientum* var. *compressa.*)	Heart	2.02		
337	Chinese dwarf wax beans (*Phaseolus vulgaris.*)	Green pods	2.01		
48	Beet (*Beta vulgaris*)	Leaves		3.17	0.27
49	Sprouting broccoli (*Brassica oleracea* var. *italica.*)	Leaves and flowering tops.	2.45		
47	Cauliflower (*Brassica oleracea* var. *botrytis.*)	do	2.02		
132	Chayote (*Sechium edule*)	Leaves and tops.	3.01		
270	Cowpea (*Vigna sinensis*)	Green pods	1.91		
14	Coriander, ongsoy (*Coriandrum sativum.*)	Leaves		2.56	0.12
62	Cucumber (*Cucumis sativus*)	Green fruits	2.73		
225	Gabi (*Colocasia esculentum*)	Leaves		2.22	0.10
205	Kauayan toto-o (*Bambusa spinosa*)	Tender portion of shoot.	2.12		
9	Kinchai (*Apium graveolens*)	Leaves		2.45	
2-A	Kangkong (*Ipomoea reptans*)	Leaves and tops.	1.84		0.13
4	Koles (*Brassica oleracea* var. *acephala*)	Leaves		5.04	
159	Kudiapa (*Amaranthus paniculatus*)	do		3.57	
1	Kolitis (*Amaranthus viridis*)	do	1.99	3.63	0.42
166	Lettuce (*Lactuca sativa*)	do		2.78	0.28
11	Libato, alugbati (*Basella rubra*)	do		3.33	0.18
40	Malungai (*Moringa oleifera*)	do		3.47	0.52
6	Mustard (*Brassica integrifolia*)	do	2.20	2.47	0.18
20	Pako (*Athyrium esculentum*)	do	2.56		
168	Patola (*Luffa cylindrica*)	Green fruits	2.96		
23	Perejil (*Petroselinum hortense*)	Leaves		2.79	0.23
180	Rutabaga (*Brassica napobrassica*)	do	2.12	2.97	0.20
43	Saluyot (*Corchorus olitorius*)	do	1.89	2.59	
21	Sarsalida (*Mollugo oppositifolia*)	do			0.36
41	Sili (*Capsicum frutescens*)	do		2.27	
39	Sitao (*Vigna sesquipedalis*)	Leaves and tops.	2.27	2.33	
45	Sitau pula (*Vigna sesquipedalis*)	Green pods	1.84		
93	American spinach (*Spinacea oleracea*)	Leaves			0.72
59	Indian spinach (*Rumex ambiguus*)	do	1.82		0.48
46	New Zealand spinach (*Tetragonia expansa*)	do			0.47
56	Prickly seeded spinach (*Spinacea oleracea*).	do	2.11	2.54	0.13
35	Squash, calabaza (*Cucurbita maxima*)	Leaves and tops.	2.06	2.31	0.43
314	Swiss chard (*Beta vulgaris* var. *cicla*)	Leaves		4.65	0.15
109	Tukod-langit (*Helminthostachys zeylanica.*)	Leaves and tops.	2.33		
344	Tango (*Chrysanthemum coronarium*)	Leaves			0.41
51	Water cress (*Radicula nasturtium aquaticum.*)	Leaves and tops.	2.13		

TABLE 15.—*Distribution of ash, phosphorus, calcium, and iron in some very common (typical) types of Philippine food plants.*

Name of plant.	Ash in dry sample.[a]	Phosphorus (P_2O_5) in—		Calcium (CaO) in—		Iron (Fe_2O_3) in—	
		Dry sample.	Ash.	Dry sample.	Ash.	Dry sample.	Ash.
LEAFY VEGETABLES.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Libato (*Basella rubra* L.)	16.08	1.51	9.37	3.33	20.68	0.18	1.09
Kolitis (*Amaranthus viridis* L.).	19.64	1.99	10.11	3.63	18.50	0.42	2.16
Petsai (*Brassica chinensis* L.)	18.20	1.74	9.56	4.65	25.52	0.15	0.81
Kamote [*Ipomoea batatas* (L.) Poir.]	10.21	0.96	9.41	0.78	7.64	0.13	1.24
Malungai (*Moringa oleifera* Lam.).	13.64	1.16	8.52	3.47	25.42	0.52	3.82
NONLEAFY VEGETABLES.							
Coconut cabbage (*Cocos nucifera* L.).	17.80	2.06	11.59	1.43	8.04	0.04	0.20
Bamboo shoot (*Bambus spinosa* Roxb.).	10.67	2.12	19.87	0.36	3.42	0.02	0.19
Squash flowers (*Cucurbita maxima* Duch.).	16.70	2.86	17.10	1.05	6.30	0.12	0.73
Patola [*Luffa cylindrica* (L.) M. Roem.].	13.50	2.39	17.71	0.81	6.01	0.06	0.41
Banana heart [*Musa errans* (Blanco) Teodoro].	16.93	2.02	11.92	0.40	2.34	0.05	0.31
FRUITS.							
Chico (*Achras zapota* L.)	1.57	0.11	7.25	0.12	7.79	0.02	1 05
Piña [*Ananas comosus* (L.) Merr.].	3.56	0.21	5.88	0.31	8.73	0.01	0.39
Papaya (*Carica papaya* L.)	3.75	0.29	7.67	0.11	2.91	0.01	.35
Naranjita (*Citrus nobilis* Lour.).	3.62	0.46	12.81	0.20	5.45	0.01	0.22
Mango (*Mangifera indica* L.).	2.90	0.48	16.39	0.05	1.89	0.01	0.42
SEEDS.							
Soy bean [*Glycine max* (L.) Merr.].	5.01	1.14	22.75	0.26	5.19	0.02	0.38
Mungo (*Phaseolus aureus* Roxb.).	4.17	1.02	24.46	0.47	11.27	0.01	0.24
Polished rice (*Oryza sativa* L.).	0.98	0.68	69.38	0.02	2.04	0.002	0.20
Corn (*Zea mays* L.)	1.46	0.65	44.52	0.08	5.48	0.01	0.48
Peanut (*Arachis hypogaea* L.).	2.62	1.15	43.89	0.33	12.59	0.003	0.11
UNDERGROUND STRUCTURES. (ROOTS, TUBERS, RHIZOMES).							
Gabi (*Colocasia esculentum* Schott.).	3.63	0.52	14.26	0.30	8.36	0.01	0.24
Ube (*Dioscorea alata* L.)	2.43	0.38	15.83	0.01	0.31	0.01	0.45
Camote [*Ipomoea batatas* (L.) Poir.].	2.62	0.35	13.30	0.14	5.19	0.01	0.19
Sincamas [*Pachyrrhizus erosus* (L.) Urb.].	4.15	0.45	10.85	0.39	9.33	0.03	0.65
Radish (*Raphanus sativus* L.)	18.49	1.73	9.35	1.22	6.61	0.11	0.60

[a] Dry sample refers to the moisture-free sample.

TABLE 16.—*Total ash and phosphorus, calcium, and iron contents in different parts of some Philippine food plants.*

[Percentages are based on moisture-free samples.]

Sample No.	Name of plant.	Part of plant used.	Ash.	Phosphorus (P_2O_5).	Calcium (CaO).	Iron (Fe_2O_3).
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
28	Ampalaya (*Momordica charantia*).	Leaves	18.77	1.37	4.36	0.47
12	Do	Green fruits	11.74	1.38	0.39	0.04
204	Saba [*Musa sapientum* L. var. *compressa*].	Heart	16.93	2.02	0.40	0.05
223	Do	Ripe fruits	2.41	0.28	0.03	0.01
48	Beet, remolacha (*Beta vulgaris*).	Leaves	22.40	1.27	3.17	0.27
175	Do	Petioles	21.01	1.28	0.52	0.14
53	Do	Roots	13.58	1.42	0.16	0.03
41	Bird pepper, sili (*Capsicum frutescens*).	Leaves	14.45	1.11	2.27	0.11
151	Do	Fruits	8.12	1.25	0.35	0.04
158	Cashew, kasoy (*Anacardium occidentale*).	Young leaves	4.28	1.03	0.18	0.10
356	Do	Mature seeds	2.74	1.23	0.04	0.01
369	Ciruelas (*Spondias purpurea*)	Young leaves	7.20	0.92	2.18	0.05
116	Do	Pulp of ripe fruits.	3.92	0.78	0.08	0.02
86	Gabi (*Colocasia esculentum*)	Corm (tuber)	3.63	0.52	0.30	0.01
225	Do	Leaves	13.51	1.19	2.22	0.10
98-B	Do	Petioles	19.24	1.65	1.43	0.08
40	Malungai (*Moringa oleifera*)	Leaves	13.64	1.16	3.47	0.52
181	Do	Young pods	14.45	1.93	0.14	0.05
244	Nangka (*Artocarpus integra*)	Pulp of ripe fruits.	3.52	0.24	0.12	0.002
247	Do	Mature seeds	2.96	0.54	0.13	0.004
327	Sincamas (*Pachyrrhizus erosus*)	Young pods	7.10	1.01	0.95	0.03
87	Do	Fleshy roots	4.15	0.45	0.39	0.03
39	Sitao (*Vigna sesquipedalis*)	Leaves and tops.	15.05	2.27	2.33	0.12
17	Do	Young pods	7.85	1.47	0.84	0.04
35	Squash, calabasa (*Cucurbita maxima*).	Leaves and tops.	17.34	2.06	2.31	0.43
301	Do	Flowers	16.70	2.86	1.05	0.12
141	Do	Fruits	9.96	1.08	0.43	0.06
29	Sweet potato, camote (*Ipomoea batatas*).	Leaves and tops.	10.21	0.96	0.78	0.13
154	Do	Tuber	2.12	0.38	0.08	0.01
172	Tamarind, sampalok (*Tamarindus indica*).	Young leaves	4.50	1.21	0.22	0.02
113	Do	Flowers	4.14	0.75	0.20	0.05
27	Do	Young fruits	4.52	0.53	1.03	0.01
281	Do	Pulp of ripe fruits.	6.08	0.53	0.20	0.02

TABLE 17.—*Analyses of certain leafy vegetables collected at the same or different localities.*

Sample No.	Common name of plant.	Date of collection (1932).	Place of collection.	Total ash.[a]	In per cent of total ash.			CaO:P_2O_5.
					P_2O_5.	CaO.	Fe_2O_3.	
				Per cent.				
8	Himbaba-ó	Mar. 28	Manila	11.08	13.24	14.35	1.05	1:0.92
8-A	Do	June 2	do	15.19	9.32	12.53	0.81	1:0.74
18	Cuchai	Apr. 6	do	16.09	10.81	9.61	0.86	1:1.12
18-A	Do	May 30	Baguio	15.62	8.87	6.46	0.77	1:1.37
9	Kinchai	Mar. 31	Manila	14.71	7.61	16.63	0.74	1:0.46
9-A	Do	July 4	Baguio	14.98	9.66	20.03	0.84	1:0.48
20	Pako	Apr. 6	Manila	13.15	19.46	1.89	0.47	1:10.3
20-A	Do	May 23	Baguio	13.25	15.65	2.38	0.37	1:6.58
11	Libato	Apr. 2	Manila	16.08	9.37	20.68	1.09	1:0.45
11-A	Do	June 2	do	16.01	11.20	12.93	0.87	1:0.87
6	Mostaza	Mar. 28	do	15.96	13.93	15.50	1.14	1:0.90
6-A	Do	June 8	Baguio	23.02	8.26	12.36	1.12	1:0.67
4	Koles	Mar. 26	Manila	16.54	10.07	30.47	0.87	1:0.33
4-A	Do	Nov. 15	Baguio	16.02	11.02	28.57	1.36	1:0.39
25	Repollo	Apr. 11	Manila	8.42	11.19	10.93	0.36	1:1.02
25-A	Do	May 26	Baguio	8.84	10.23	9.98	0.38	1:1.03
43	Saluyot	May 19	Manila	14.61	12.97	17.74	0.50	1:0.73
43-A	Do	June 2	Baguio	13.31	10.13	17.75	0.92	1:0.57
29	Camote	Apr. 18	Manila	10.21	9.41	7.64	1.24	1:1.23
29-A	Do	June 6	Baguio	12.72	10.75	6.49	1.49	1:1.66
2	Kangkong	Mar. 23	Manila	12.18	14.42	4.96	1.29	1:2.91
2-A	Do	May 16	do	12.59	15.89	6.55	1.00	1:2.43
2-B	Do	June 15	do	11.78	13.30	7.16	0.95	1:1.86
23	Perejil	Apr. 8	do	15.90	8.12	17.55	1.42	1:0.46
23-A	Do	June 6	Baguio	15.53	8.55	13.96	2.02	1:0.61

[a] The percentage of total ash is based on the moisture-free sample.

TABLE 18.—*Vegetables and fruits having a calcium oxide-phosphorus pentoxide ratio of approximately 1 : 3.*

Sample No.	Name of plant.	Part used.	Phosphorus (P_2O_5) in ash.	Calcium (CaO) in ash.	Ratio CaO: P_2O_5.
			Per cent.	*Per cent.*	
16	Alibangbang	Leaves	17.96	6.50	1 · 2.7
211	Cauliflower	Leaves and flower heads	16.80	6.15	1 · 2.7
331	Buyok-buyok	Leaves	21.61	6.19	1 : 3.5
132	Chayote	do	20.45	6.09	1 : 3.3
89	Sili	do	14.72	5.71	1 : 2.6
301	Calabaza	Leaves and top	17.10	6.30	1 : 2.7
22	Chicharo	Green pods	26.87	10.12	1 : 2.7
245	Sibuyas	Leaf bases	22.63	6.83	1 : 3.3
172	Ates	Fruits	16.50	5.69	1 : 2.8
273	Chico mamey	do	6.94	2.32	1 : 3.0
317	Chinese sapote	do	10.11	3.63	1 : 2.8
167	Makopa	do	13.95	4.87	1 : 2.8
170	Santol	do	4.47	1.45	1 : 3.1
195	Apricot	do	14.90	4.56	1 : 3.2
275	Susong calabao	do	8.41	2.63	1 : 3.2
254	Chinese carrot	Root	14.96	4.51	1 : 3.3
177	Sweet potato	do	11.45	4.38	1 : 2.6
259	American parsnip	do	18.18	5.63	1 : 3.2
346	Japanese radish	do	10.30	3.78	1 : 2.7

TABLE 19.—*Some common Philippine vegetables that have a comparatively high calcium and low phosphorus content.*

[Percentages were calculated on the moisture-free samples.]

Sample No.	Common name of plant.	Ash.	Phosphorus (P_2O_5).	Calcium (CaO).	Ratio CaO:P_2O_5.
		Per cent.	*Per cent.*	*Per cent.*	
159	Kudiapa	18.69	1.40	3.67	1 : 0.4
1	Kolitis	19.64	1.99	3.63	1 : 0.5
9	Kinchai	14.71	1.12	2.45	1 : 0.5
11	Libato	16.08	1.51	3.33	1 : 0.5
48	Beet	22.40	1.27	3.17	1 : 0.4
314	Swiss chard	20.27	0.73	3.14	1 : 0.2
10	Petsai	18.20	1.74	4.65	1 : 0.4
237	Mustard	18.94	1.90	3.30	1 : 0.6
4	Koles	16.54	1.67	5.04	1 : 0.3
41	Sili	14.45	1.11	2.27	1 : 0.5
225	Gabi	13.51	1.19	2.22	1 : 0.5
14	Ongsoy	10.69	1.16	2.56	1 : 0.5
27	Lettuce	17.55	1.60	2.78	1 : 0.5
28	Ampalaya	18.77	1.37	4.36	1 : 0.3
23	Perejil	15.90	1.29	2.79	1 : 0.5

TABLE 20.—*Leaves of vegetables rich in iron.*

[Average moisture content about 87 per cent.]

Sample No.	Common name of vegetable.	Milligrams of iron (Fe_2O_3) in 100 grams of fresh vegetables.	Sample No.	Common name of vegetable.	Milligrams of iron (Fe_2O_3) in 100 grams of fresh vegetables.
8	Himbaba-ó	30	109	Tukod-langit	15
19	Sibuyas	11	29	Kamote	20
18	Kuchai	12	2-A	Kangkong	13
182	Halon	17	27	Lechugas	20
1	Kolitis	45	320	Kamoteng-kahoy	11
158	Kasoy	25	21	Malagoso	30
9	Kinchai	15	28	Ampalaya	64
11	Libato	17	331	Buyok-buyok	14
16	Alibangbang	14	40	Malungai	10
48	Remolacha	35	23	Perejil	39
314	Swiss chard	13	335	Kapilan	14
6	Mostaza	16	137	Pokeweed	13
180	Rutabaga	23	315	Japanese plantain	24
4	Koles	16	51	Water cress	15
41	Siling labuyo	21	59	Indian spinach	13
337	Water fern	12	56	Prickly-seeded spinach	17
344	Tung-hao	25	369	Ciruelas	13
107	Boboy	13	46	New Zealand spinach	37
225	Gabi	23	119	Toston	67
43	Saluyot	13	332	Sintas-sintasan	11
14	Coriander	16	39	Sitao	14
36	Bago	10	336	Seguidillas (green pods)	17

THE PHILIPPINE SPECIES OF SELAGINELLA

By A. H. G. Alston

Of the British Museum (Natural History), London

TWO PLATES

Work on this revision was originally started with the material at the British Museum (Natural History) and a loan from Dr. E. B. Copeland which included both the specimens in his private herbarium and those belonging to the University of California. Later portions of the Philippine collections at Kew, Washington, New York, and Manila were sent on loan. The author wishes to thank Doctor Copeland and the directors of the above institutions for the help thus given.

The chief difficulty has been the large number of species described by Hieronymus; twenty-eight of these have been reduced to synonymy; besides these "species" Hieronymus has scattered a vast number of manuscript names in various herbaria, none of which have been taken up or quoted. In spite of this great reduction in the number of names, it is probable that the process has not been carried far enough, as a number of somewhat dubious species have been retained. In this connection the attention of field workers is especially drawn to the large erect species, Nos. 31 to 46, where further material is most likely to lead to modifications of the taxonomy.

The distribution of the species within the Archipelago and the floristic relations indicated by their range outside is of considerable interest. Two species show a connection with China and Japan. *Selaginella Möllendorffii* Hieron. and *S. boninensis* Bak. are found, as might be expected, in the northern part of the Archipelago. Some species show connections with Borneo and Celebes, especially the latter. It is probable that some of the Philippine species will have to be reduced to Borneo species; the author hopes to deal with this in a later paper, on the Borneo species.

Key to the Philippine species of Selaginella.

Leaves dimorphic throughout.
  Sporophylls uniform; cones tetragonous.
    Plants xerophytic; stem curling up when dried.
      1. *S. tamariscina.*

Plants not xerophytic.
Lateral leaves all spreading, often contiguous, usually denticulate or ciliate; stems usually prostrate or ascending.
Stems pubescent ..... 27. *S. biformis.*
Stems glabrous.
Stems not scandent.
Axillary leaves not auriculate.
Lateral leaves ovate-lanceolate.
Lateral leaves ciliate, contiguous.
2. *S. repanda.*
Lateral leaves denticulate, distant.
3. *S. remotifolia.*
Lateral leaves oblong-lanceolate, separated by less than their breadth.
Stems prostrate.
Lateral leaves ciliate.
4. *S. Springiana.*
Lateral leaves denticulate.
5. *S. negrosensis.*
Stems suberect..... 6. *S. ascendens.*
Axillary leaves auriculate..... 7. *S. auriculata.*
Stems climbing by means of short rhizophores.
Median leaves obtuse..... 8. *S. Cumingiana.*
Median leaves aristate..... 9. *S. alligans.*
Lateral leaves of main stem distant, ascending, entire or subentire; stems ascending or scandent, usually pleiostelic.
Median leaves margined.
Axillary leaves not auricled ..... 10. *S. delicatula.*
Axillary leaves auricled; auricles laciniate.
11. *S. lacerata.*
Median leaves not margined.
Axillary leaves not auriculate, overlapping the branches ..... 12. *S. gastrophylla.*
Axillary leaves auriculate, auricles entire.
Stems ascending, straight, ovate-oblong in cross section, usually tripinnate; steles normally 7.
13. *S. Usterii.*
Stems scandent, flexuose, usually subterete, quadripinnate; steles normally 3 to 5.
14. *S. Engleri.*

Sporophylls dimorphic; cones flattened.
Main stems creeping, rooting at intervals.
Stems under 4 mm broad (including leaves).
Lateral leaves ovate, scarcely longer than broad.
Lateral leaves not ciliate at base....15. *S. nummularia.*
Lateral leaves ciliate at base.....16. *S. intertexta.*
Lateral leaves much longer than broad.
Lateral leaves contiguous..... 17. *S. apoensis.*
Lateral leaves distant ..... 18. *S. ciliaris.*

Stems about 6 mm broad (including leaves).
Sporophylls of upper series narrowly lanceolate; rhizophores filiform ..... 19. *S. boninensis.*
Sporophylls ovate-lanceolate; rhizophores robust. 20. *S. opaca.*
Main stems erect, rooting at base.
Stems up to 8 mm across, including leaves..... 21. *S. ornata.*
Stems under 8 mm across, including leaves.
Median leaves acute, not aristate; stems not stoloniferous; lateral leaves ciliolate at base.
Lateral leaves ovate; stems simple below. 22. *S. Llanosii.*
Lateral leaves elliptic-lanceolate; stems branched from the base ..... 23. *S. philippina.*
Median leaves aristate.
Lower sporophylls and lateral leaves ciliate.
Stems stoloniferous ..... 24. *S. myosuroides.*
Stems not stoloniferous..... 22. *S. Llanosii.*
Lower bracts and lateral leaves denticulate; stems not stoloniferous.
Median leaves elliptic; arista as long as lamina. 25. *S. aristata.*
Median leaves broadly ovate; arista half as long as lamina ..... 26. *S. Eschscholzii.*
Leaves uniform at base of erect stems.
Stems pubescent, quadrangular..... 27. *S. biformis.*
Stems glabrous.
Stems terete; leaves drying light green; median leaves shortly cuspidate; lateral leaves with false nerves.
Median leaves not margined.
Outer half of median leaves broader than inner half; lateral leaves ovate-lanceolate..... 28. *S. polyura.*
Outer half of median leaves equaling the inner half; lateral leaves ovate-oblong..... 29. *S. peltata.*
Median leaves white-margined; stems quadrangular at base. 30. *S. Möllendorffii.*
Stems irregularly angled or compressed; leaves usually drying dark green above.
Axillary leaves ovate, not auriculate.
Median leaves acute, not aristate.
Sporophylls aristate; lateral leaves up to 8 mm long. 31. *S. magnifica.*
Sporophylls acute; lateral leaves up to 6 mm long. 32. *S. procera.*
Median leaves long-aristate.
Median leaves white-margined.... 30. *S. Möllendorffii.*
Median leaves not margined.
Lateral leaves strongly ciliate at base. 40. *S. Jagorii.*

Lateral leaves entire or ciliolate at base.
Lateral leaves strongly dimorphic at base of branches, leaves drying dark green above. 33. *S. Elmeri.*
Lateral leaves only slightly dimorphic at base of branches; leaves drying dark green above.
Lateral leaves of ultimate branchlets overlapping, lanceolate. 34. *S. latifrons.*
Lateral leaves of ultimate branchlets laxer, ovate-lanceolate. 35. *S. agusanensis.*
Axillary leaves lanceolate, often auriculate and ciliate at base.
Leaves erect, subequal throughout the lower two-thirds of the erect stems.
Median leaves long-aristate; arista at least one-third as long as lamina.
Lateral leaves narrowed towards the base, broadest near the middle ..... 44. *S. luzonensis.*
Lateral leaves rounded and broadest at base.
Lateral leaves up to 6 mm long, about three times as long as broad ..... 36. *S. Copelandii.*
Lateral leaves up to 4.5 mm long, about twice as long as broad.
Arista of median leaves as long as lamina; lateral leaves oblong-lanceolate ..... 37. *S. Ramosii.*
Arista of median leaves about half as long as lamina; lateral leaves oblong-ovate ..... 38. *S. Neei.*
Median leaves acuminate or shortly aristate.
Ultimate branchlets 10 mm across (including leaves). 31. *S. magnifica.*
Ultimate branchlets up to 5 mm across.
Median leaves of main stem closely ciliolate. 39. *S. Fenixii.*
Median leaves entire or denticulate.
Lateral leaves shining, closely imbricate; sporophylls acuminate ..... 45. *S. flabelloides.*
Lateral leaves not shining, laxer; sporophylls subacute. 46. *S. cupressina.*
Leaves spreading and strongly dimorphic almost to base of erect stems.
Median leaves long-aristate; arista at least one-third as long as lamina ..... 40. *S. Jagorii.*
Median leaves acuminate or shortly-aristate.
Largest lateral leaves 6 mm long..... 41. *S. halconensis.*
Largest lateral leaves 4 mm long.
Lateral leaves contiguous..... 42. *S. aenea.*
Lateral leaves distant..... 43. *S. Presliana.*

1. SELAGINELLA TAMARISCINA (Beauv.) Spring.

Selaginella tamariscina (Beauv.) SPRING in Bull. Ac. Brux. 10 (1843) 136.
Stachygynandrum tamariscinum BEAUV., Prod. (1805) 106.
? *Lycopodium involvens* SW., Syn. Fil. (1806) 182.
Selaginella circinalis "(L.)" PRESL, Bot. Bern. (1844) 153.
Selaginella convolvens v. A. v. R. in Bull. Jard. Bot. Buitenz. II 11 (1923) 23.

Philippines, without exact locality, *Cuming 1997, 2001.* LUZON, Cagayan Province, Mount Cura, *For. Bur. 16838 Curran:* Ilocos Norte Province, Mount Nagapatan, *Bur. Sci. 33226 Ramos:* Bontoc Subprovince, Bauco, *Vanoverbergh 426:* Benguet Subprovince, Trinidad, *Williams 1597;* Mount Pulog, *Merrill 6389:* Zambales Province, Mount Tapolao, *Bur. Sci. 5123 Ramos, 44755 Ramos and Edaño:* Bataan Province, upper Lamao River, *Williams 785:* Rizal Province, Susong Dalaga, *Bur. Sci. 13602 Ramos, 19244 Reillo:* Laguna Province, Mount Banahao, *For. Bur. 7994 Curran and Merritt:* Batangas Province, Mount Batulao, *Bur. Sci. 22338 Ramos.*

Geographical range.—China and Japan, reported from Celebes.

2. SELAGINELLA REPANDA (Desv.) Spring.

Selaginella repanda (Desv.) SPRING in Gaudich. Voy. Bonite Bot. 1 (1844–1846) 329.
Selaginella barbata (Kaulf.) SPRING in Bull. Ac. Brux. 10 (1843) 226.
Lycopodium repandum DESV. ex Poir., Encycl. Suppl. 3 (1814) 558.
Lycopodium barbatum KAULF., Enum. Fil. (1824) 181.
Selaginella ceratocaulos v. A. v. R. in Bull. Jard. Bot. Buitenz. II 16 (1914) 41.

Philippines, without exact locality, *Cuming 2014* (in herb. Desvaux). LUZON, Apayao Subprovince, *Bur. Sci. 28262 Fénix:* Bontoc Subprovince, Mount Masapilid, *Bur. Sci. 38243 Ramos and Edaño:* Nueva Vizcaya Province, Dupax, *Bur. Sci. 20142, 20137 McGregor:* Nueva Ecija Province, Mount Umingan, *Bur. Sci. 26277 Ramos and Edaño:* Bulacan Province, Angat, *Bur. Sci. 21670 Ramos:* Manila, *Merrill 7112, 7124:* Rizal Province, Montalban, *Merrill 7123, Bur. Sci. 9540 Robinson, Loher 1317;* Nawa, *Topping 1013, 1047;* Tanay, *Bur. Sci. 11880 Robinson and Ramos;* Antipolo, *Bur. Sci. 29531 Ramos and Edaño.* PANAY, Tigorn River, *Bur. Sci. 18109 Robinson.*

Geographical range.—Indo-Malayan.

3. SELAGINELLA REMOTIFOLIA Spring.

Selaginella remotifolia SPRING in Miq. Pl. Jungh. 3 (1854) 276.

LUZON, Benguet Subprovince, Baguio, *Merrill 7738, 7798, 7731;* Baguio, *Elmer 14301;* Pauai, *Copeland:* Rizal Province, Montalban, *Loher 975.*

Geographical range.—Java, Sumatra (type locality), China, Formosa, and Japan.

This species is very similar to the African *S. Kraussiana* (Kze.) A. Br. and has been united with it by some authors.

4. SELAGINELLA SPRINGIANA v. A. v. R.

Selaginella Springiana v. A. v. R. in Bull. Jard. Bot. Buitenz. II 11 (1913) 28.

PALAWAN, Iwahig River, *Merrill 714.* MINDANAO, Zamboanga district, *Bur. Sci. 36841 Ramos and Edaño.*

Geographical range.—Sumatra and Borneo.

5. SELAGINELLA NEGROSENSIS Hieron.

Selaginella negrosensis HIERON. in Elm. Leafl. Phil. Bot. 6 (1913) 2007.

Selaginella Perkinsiae HIERON. in Elm. Leafl. Phil. Bot. 6 (1913) 2610.

PANAY, Capiz Province, Kinablangan, *Bur. Sci. 46066 Edaño:* Capiz Province, Libucao, *Bur. Sci. 31434 Ramos and Edaño.* NEGROS, Dumaguete, Cuernos Mountains, *Elmer 10231* (type of *Selaginella negrosensis*). MINDANAO, Todaya, Mount Apo, *Elmer 11847* (type of *Selaginella Perkinsiae*).

Geographical range.—Philippines (Panay, Negros, and Mindanao).

6. SELAGINELLA ASCENDENS v. A. v. R.

Selaginella ascendens v. A. v. R. in Bull. Jard. Bot. Buitenz. II 11 (1913) 33.

PALAWAN, San Antonio Bay, *Merrill 834.* JOLO, *Burbidge s. n.*

Geographical range.—Borneo, Celebes, Sumatra, Java, and Malay Peninsula.

7. SELAGINELLA AURICULATA Spring.

Selaginella auriculata SPRING in Bull. Ac. Brux. 10 (1843) 142.

Lycopodium atrovirens PRESL, Rel. Haenk. 1 (1825) 79, *t. 12, f. 2.* non *S. atrovirens* Lojacono Pojero.

Selaginella amphylotis A. BR. in Ann. Sci. Nat. 3 (1865) 274.

Selaginella plumosa var. *gracilis* PRESL, Bot. Bem. (1844) 153.

Philippines, without exact locality, *Cuming 2013* (type). LUZON, Cagayan Province, Sitio Viola, *For. Bur. 19582 Curran, Bur. Sci. 13889, 14543, 14545 Ramos, 16648 Bacani;* Abulug River, *Weber 1580, 1569;* Tamdagan River, *Bur. Sci. 79646 Edaño;* Claveria, *Bur. Sci. 10738 McGregor:* Ilocos Norte Province, Bangui to Claveria, *Bur. Sci. 33065 Ramos.*

Geographical range.—Northern Luzon.

Haenke's locality "Cordilleras de Chile" was doubtless a mistake.

8. SELAGINELLA CUMINGIANA Spring.

Selaginella Cumingiana SPRING in Bull. Ac. Brux. 10 (1843) 146.
Selaginella Cumingiana var. *simplici-ramosa* SPRING in Mem. Ac. Belg. 24 (1850) 127.

Philippines, without exact locality, *Cuming 2011, 2012* (type). LUZON, Rizal Province, Montalban, *Loher 12786.* MINDORO, Binabay River, *Merrill 6014;* Puerto Galera, *Kienholz 15201;* Mount Tablagun, *Merritt 11007.* LEYTE, *Wenzel 381.* SAMAR, Catubig River, *Bur. Sci. 24834 Edaño.* MINDANAO, Davao Province, Mount Mayo, *Bur. Sci. 49591 Ramos and Edaño:* Surigao Province, Placer, *Wenzel 3435.*

Geographical range.—Philippine Islands.

9. SELAGINELLA ALLIGANS Hieron.

Selaginella alligans HIERON. in Elm. Leafl. Phil. Bot. 6 (1913) 2012.

LUZON, Isabela Province, Mount Moises, *Clemens 16544:* Rizal Province, Montalban, *Loher 12057;* Angcolog, *Loher s. n.;* Helugan River, *Loher 12887:* Laguna Province, Helugan River, *For. Bur. 19270 Curran;* San Antonio, *Bur. Sci. 12084, 20598 Ramos;* Pasto, *Bur. Sci. 10040 Ramos:* Tayabas Province, Lucban, *Elmer 9271, 7982;* Infanta, *Bur. Sci. 9366* Robinson; Mount Banahao, *For. Bur. 927 Whitford:* Camarines Sur Province, Mount Isarog, *Bur. Sci. 76540 Edaño:* Sorsogon Province, Irosin, (Mount Bulusan), *Elmer 16073.* CATANDUANES, *Bur. Sci. 30235 Ramos.* MINDANAO, Surigao Province, Diuata Mountains, *Bur. Sci. 83463 Ramos and Convocar.*

Geographical range.—Philippine Islands and Celebes (?).

Hieronymus quotes *Elmer 7124, 7982, 8001, Jagor 791,* and *Weber 1489* without distinguishing a type. *Wenzel 410* probably belongs here; the median leaves are more shortly acuminate.

Elmer (*7982*) notes "scandent upon shrubs and forming rather tangled masses some 15 ft. from the ground."

10. SELAGINELLA DELICATULA (Desv.) Alston.

Selaginella delicatula (Desv.) ALSTON in Journ. Bot. 70 (1932) 282.
Lycopodium delicatulum DESV. ex Poir., Encycl. Suppl. 3 (1814) 584.
Lycopodium Pouzolzianum GAUD. in Freyc. Voy. Bot. 1 (1826) 287.
Selaginella Pouzolziana (Gaud.) SPRING in Bull. Ac. Brux. 10 (1843) 145.
Selaginella pectinata PRESL, Bot. Bem. (1844) 153.
Selaginella Pouzolziana philippinensis HIERON. in Engl. and Prantl Nat. Pfl. 4 (1901) 701.
Selaginella Pouzolziana punctata HIERON. in Elm. Leafl. Phil. Bot. 6 (1913) 2049, 2050.
Selaginella Pouzolziana typica HIERON. in Elm. Leafl. Phil. Bot. 6 (1913) 2049.
Selaginella davaoensis HIERON. in Elm. Leafl. Philip. Bot. 6 (1913) 2053.

Philippines, without exact locality, *Cuming 1995, Wallis 114.* BATAN, Batanes Province, Santo Domingo de Basco, *Bur. Sci. 3667 Fenix, Bur. Sci. 10196 McGregor.* LUZON, Cagayan Province, Peñablanca, *Bur. Sci. 27191 Ramos:* Benguet Subprovince, *Merrill 7727, 7739;* Baguio, *Topping 228, 328;* Sablan Trail, *Topping 1099:* Nueva Vizcaya Province, Bayombong, *Bur. Sci. 8165 Ramos:* Pampanga Province, Mount Pinatubo, *Elmer 22009, 22129:* Laguna Province, Mount Maquiling, *For. Bur. 26113 Mabesa;* Los Baños, (Mount Maquiling), *Elmer 18074, 18384, Merrill 5111, 619, Copeland 12, 2013, Topping 945;* Mount Banahao, *Bur. Sci. 9769 Robinson;* Los Baños, *Topping 709, 677;* Pagsanjan, *Topping 511, 997;* Majayjay, *Topping 983:* Tayabas Province, Lucban, *Elmer 7918, Bur. Sci. 47361 McGregor;* Mount Banahao, *For. Bur. 974 Whitford:* Sorsogon Province, Irosin, (Mount Bulusan), *Elmer 16876.* MINDORO, *Merrill 12037.* LEYTE, Jaro, *Wenzel 635.* MINDANAO, Davao Province, Todaya (Mount Apo), *Elmer 11586:* Lanao Province, Lanao district, *For. Bur. 25270, 25275 Alvarez.* SULU IS., *Burbidge.*

Geographical range.—Indo-Malayan.

Hieronymus compares his *Selaginella davaoensis* with *Selaginella Wallichii* (Hk. and Gr.) Spring but not with this species; it appears to be simply a denser form.

11. SELAGINELLA LACERATA Warb.

Selaginella lacerata WARB. in Monsunia 1 (1900) 106, 120.
Selaginella pectinata var. *acutissima* PRESL, Bot. Bem. (1844) 153.
Selaginella cyatheoides SPRING in Bull. Ac. Brux. 10 (1843) 145.

Philippines, without exact locality, *Cuming 2010* (type). PANAY, Capiz Province, Mount Dilana, *Bur. Sci. 46055 Edaño;* Libucao, *Bur. Sci. 35505 Martelino and Edaño:* Iloilo Province,

Tigom River, *Bur. Sci. 18124;* Ulian River, *Bur. Sci. 18171 Robinson:* Antique Province, Culasi, *Bur. Sci. 32222 McGregor.* NEGROS, Gimogon River, *Copeland 61;* Dumaguete, *Elmer 9984, 10346.*

Geographical range.—Confined to Panay and Negros.

Selaginella plana (Desv.) Hieron., *Topping 1049,* was collected near Manila; it was doubtless an escape from cultivation.

12. SELAGINELLA GASTROPHYLLA Warb.

Selaginella gastrophylla WARB. in Monsunia 1 (1900) 107, 121, *t. 4, f. D.*

MINDANAO, Zamboanga Province, Mount Dagatpan, *Warburg 14192a:* Lanao Province, Lake Lanao, *Clemens s. n.;* Taraca River, *Mearns s. n.;* between Malabang and Lake Lanao, *Bartsch 459:* Zamboanga Province, Malangas, *Bur. Sci. 36826 Ramos and Edaño;* Pantar, *Mearns 116.*

Geographical range.—Mindanao and Borneo ?. Warburg quotes also Sanguir Islands, *Warburg 16603.*

Probably the same as *Selaginella conferta* Moore from Borneo.

13. SELAGINELLA USTERII Hieron.

Selaginella Usterii HIERON. ex Usteri Beitr. Phil. Veg. (1905) 135; in Vierteljahresschr. Nat. Ges. Zürich 50 (1906) 475; in Elm. Leafl. Phil. Bot. 6 (1913) 2055.

Lycopodium chilense "Willd.;" PRESL, Rel. Haenk. 1 (1825) 79.

Selaginella Pouzolziana "Spring;" BRACK., U. S. Expl. Exped. (1854) 333.

LUZON, Laguna Province, Mount Banahao, *Bur. Sci. ? Yates:* Tayabas Province, Kabibihan, *Bur. Sci. 13249 Ramos:* Camarines Sur Province, Botol River, *Bur. Sci. 76500 Edaño;* Paracale, *Bur. Sci. 33553 Ramos and Edaño;* Pasacao, *Merrill 3368:* Sorsogon Province, Irosin (Mount Bulusan), *Elmer 16069, 15454.* CATANDUANES, *Bur. Sci. 75680 Ramos and Edaño.* MASBATE, *Merrill 2749.* CEBU, Mount Limusan, *Bur. Sci. 11037 Ramos.* BOHOL, Bilar, *Bur. Sci. 42989 Ramos.* BILIRAN, *Bur. Sci. 18659 McGregor.* LEYTE, Dagami, *Wenzel 391, 81, 50, For. Bur. 16919 Whitford;* Palo, *Elmer 7065;* Tacloban, *Copeland 96.* SAMAR, Loquilocon, *Bur. Sci. 43768, 43720, 43784 McGregor;* Catubig River, *Merrill 5202.* SIARGAO, *Bur. Sci. 35023 Ramos and Pascasio.* MINDANAO, Davao Province, Todaya (Mount Apo), *Elmer 10969;* Mati, *Bur. Sci. 49339 Ramos and Edaño;* Davao district, *Bur. Sci. 15855 Fenix:* Agusan Province, Cabadbaran (Mount Urdaneta), *Elmer 13365, 13385, 14312;* Paz, *Weber 1199, Bur. Sci. 15895 Fenix:* Zamboanga Province, Zamboanga district, *Merrill 8241;* Malangas, *Bur. Sci. 36753, 36826 Ramos*

and Edaño; Santa Maria, *Bur. Sci. 16449 Reillo:* Bukidnon Province, Tangkulan, *Bur. Sci. 26146 Fenix:* Cotabato Province, Reina Regente, *Bur. Sci. 11648 Robinson;* near Fort Caldera, *Brackenridge 6.* SULU, *Burbidge s. n.*

Geographical range.—Southern Luzon southwards to the Sulu Islands.

Elmer (No 7065) notes, "often 1 meter high and branched; stems wiry; very common near sea-level." Very similar species are found in Celebes and the Moluccas.

14. SELAGINELLA ENGLERI Hieron.

Selaginella Engleri HIERON. in Engl. and Prantl Nat. Pfl. 1 (1901) 704.

Selaginella Whitfordii HIERON. in Elm. Leafl. Phil. Bot. 6 (1913) 2061.

LUZON, Apayao Subprovince, Tauit, *Worcester 10754, Bur. Sci. 28169 Fenix;* Abulug-Narig Trail, *Weber 1551:* Cagayan Province, Sitio Viola, *For. Bur. 19584, 19586 Curran, Bur. Sci. 7548, 13803 Ramos;* Tamdagan River, *Bur. Sci. 79647 Edaño;* Gonzaga River, *Bur. Sci. 78684 Edaño:* Laguna Province, Pagsanjan, *Copeland 11, 1990;* Mani, *Wichura 1930;* Majayjay, *Topping 978:* Tayabas Province, Atimonan, *For. Bur. 626 Whitford;* Lucban, *Elmer 7919;* Casiguran, *Bur. Sci. 45390 Ramos and Edaño, Mearns 2985;* between Malicboy and Atimonan, *Topping 1317;* Tagcauayan, *Bur. Sci. 13344 Ramos;* Mount Banahao, *For. Bur. Whitford 969:* Camarines Sur Province, Mount Madooy, *Bur. Sci. 75791 Edaño:* Sorsogon Province, Irosin (Mount Bulusan), *Elmer 15454, 16069.* POLILLO, *Bur. Sci. 6907 Robinson, Bur. Sci. 10293 McGregor.* CATANDUANES, *Bur. Sci. 75670 Ramos and Edaño;* Mount Mareguidon, *Bur. Sci. 30305 Ramos.* ALABAT, *Bur. Sci. 48370 Ramos and Edaño.* MINDORO, Alag River, *Merrill 6016;* Paluan, *Bur. Sci. 39663 Ramos;* Baco River, *Merrill 1805.* PANAY, Capiz Province, Mount Timbaban, *Bur. Sci. 42345 Edaño;* Mount Ditana, *Bur. Sci. 46074 Edaño;* Jamindan, *Bur. Sci. 31070 Ramos and Edaño;* Libucao, *Bur. Sci. 35292 Martelino and Edaño.* NEGROS, Dumaguete (Cuernos Mountain), *Elmer 9617;* Mount Canlaon, *Merrill 8026;* Gimagaan River, *For. Bur. 1663 Whitford.* LEYTE, Jaro, *Wenzel 475, 582, 1372.* SAMAR, Loquilocon, *Bur. Sci. 43739, 43782 McGregor.* CAMIGUIN, Mount Malabsing, *Bur. Sci. 79621 Edaño.* MINDANAO, Agusan Province, Cabadbaran (Mount Urdaneta), *Elmer 13365;* Agusan River, *Merrill 7338, Weber 1199:* Surigao Province, Placer, *Wenzel 2934, 3336, 3457:* Davao Province, Todaya, *Copeland 1453:*

Zamboanga Province, Sax River, *Merrill 8234*. DINAGAT, *Bur. Sci. 83450 Ramos and Convocar.*

Geographical range.—Philippine Islands.

Of the characters given by Hieronymus to distinguish *Selaginella Whitfordii*, that of the smaller leaves is the most conspicuous, but the leaves often vary considerably on the same specimen (for example, *Merrill 7338*) ; the number of steles and the roughness of the stems also vary.

15. SELAGINELLA NUMMULARIA Warb.

Selaginella nummularia WARB. in Monsunia 1 (1900) 108, 123.
Selaginella cuernosensis HIERON. in Elm. Leafl. Phil. Bot. 6 (1913) 2027.
Selaginella maquilingensis HIERON. in Elm. Leafl. Phil. Bot. 6 (1913) 2029.

LUZON, without locality, *Jagor* (type, not seen) : Isabela Province, Mount Moises, *Clemens s. n.:* Rizal Province, Angilog, *Loher 14163:* Laguna Province, Mount Maquiling, *Bur. Sci. 9741, 9753 Robinson, Merrill 629, 6304, Bur. Sci. 16872 Serviñas, Elmer 17689, 18364, Baker 284, Copeland 60, 2012:* Tayabas Province, Mount Binuang, *Bur. Sci. 28793 Ramos and Edaño.* NEGROS, Dumaguete (Cuernos Mountain), *Elmer 9651.*

Geographical range.—Amboina (Brooks).

The type has not been seen but van Alderwerelt van Rosenburg, in Bull. Jard. Bot. Buit. III 2 (1920) 180, refers *Elmer 17689* and *18364* to this species.

16. SELAGINELLA INTERTEXTA Spring. Plate 2, figs. 1–4.

Selaginella intertexta SPRING in Bull. Ac. Brux. 10 (1843) 233.

Philippines, without locality, *Cuming 2015.* LUZON, Ilocos Norte Province, Solsona, *Bur. Sci. 43683 McGregor:* La Union Province, Bauang, *Bur. Sci. 12972 Fenix;* San Fernando, *R. Lete 276:* Benguet Subprovince, without locality, *Bur. Sci. 5308 Ramos;* Baguio, *Williams 1260;* Sablang, *Bur. Sci. 12775 Fenix:* Pangasinan Province, Mount San Isidro, *Bur. Sci. 29937, 29949 Fenix;* Umingan, *Bur. Sci. 17782 Otanes.*

Geographical range.—Northern Luzon, on rocks in streams.

17. SELAGINELLA APOENSIS Hieron.

Selaginella apoensis HIERON. in Elm. Leafl. Phil. Bot. 6 (1913) 2028.

MINDANAO, Davao Province, Todaya (Mount Apo), *Elmer 11772.*

Geographical range.—Celebes (*Kjellberg 3662*).

18. SELAGINELLA CILIARIS (Retz.) Spring.

Selaginella ciliaris (Retz.) SPRING in Bull. Ac. Brux. 10 (1843) 231.
Lycopodium ciliare RETZ. Obs. 5 (1789) 32.
Lycopodium Belangeri BORY in Bel. Voy. Bot. 2 (1833) 12, *t. 1, f. 2.*
Selaginella Belangeri (Bory) SPRING in Mem. Ac. Belg. 24 (1850) 142.

LUZON, Benguet Subprovince, Sablang, *Bur. Sci. 12598 Fenix:* Nueva Vizcaya Province, Kiangan, *Topping 874:* Tarlac Province, Concepcion, *Merrill 3621:* Bataan Province, Lamao River, *Merrill 3775;* Mount Mariveles, *Copeland 84:* Rizal Province, Antipolo, *Bur. Sci. 16960 Ramos;* Bosoboso, *For. Bur. 3354 Ahern's collector;* Montalban, *Loher s. n.;* San Pedro Makati, *Merrill 7125. 7127;* Montalban, *Merrill 7120;* San Juan del Monte, *Merrill 673:* Manila, *Clemens s. n., Topping 644:* Batangas Province, Taal Volcano, *Merrill 10602:* Sorsogon Province, Irosin (Mount Bulusan), *Elmer 15510.* POLILLO, *Bur. Sci. 6911 Robinson.* LEYTE, Dagami, *Wenzel 435;* Palo, *Elmer 7076.* PALAWAN, San Antonio Bay, *Merrill 5253.* GUIMARAS, *Bur. Sci. 18012 Robinson.* SAMAR, Catubig River, *Bur. Sci. 24737 Edaño.* MINDANAO, Lanao Province, Camp Keithley, Lake Lanao, *Clemens 19.*

Geographical range.—India to southern China and northern Australia.

This is one of the most widely distributed species at low elevation; it probably endures a drier climate than most species.

19. SELAGINELLA BONINENSIS Baker.

Selaginella boninensis BAKER in Journ. Bot. 23 (1885) 178.
Selaginella Somai HAYATA, Ic. Pl. Formos. 7 (1918) 101, *f. 66.*

LUZON, Bataan Province, Mount Mariveles, *Merrill 3749, 7607.*

Geographical range.—Bonin Islands and Formosa.

20. SELAGINELLA OPACA Warb.

Selaginella opaca WARB. in Monsunia 1 (1900) 108, 122.
Selaginella Mearnsii HIERON. in Elm. Leafl. Phil. Bot. 6 (1913) 2018.
Selaginella pervaga HIERON. in Elm. Leafl. Phil. Bot. 6 (1913) 2021.
Selaginella debilis "Spring" ALSTON in Journ. Bot. 69 (1931) 256.

LUZON, Benguet Subprovince, Mount Tonglon, *Merrill 7730;* Baguio, *Elmer 8358, Williams 1264;* Haight's Place, *For. Bur. 4237 Mearns;* Pauai, *Bur. Sci. 8404, 8446 McGregor, Copeland s. n.;* Mount Singakalsa, *Bur. Sci. 82446 Quisumbing and Sulit:* Kalinga Subprovince, Mount Masingit, *Bur. Sci. 37586 Ramos and Edaño:* Ifugao Subprovince, Mount Polis, *Bur. Sci. 19807 McGregor:* Laguna Province, Mount Maquiling, *Loher 1318.* NEGROS, Oriental Negros Province, Dumaguete (Cuernos Mountains), *Elmer 9638;* Canlaon Volcano, *Merrill 6964.* MINDANAO,

Misamis Province, Mount Malindang, *For. Bur. 4634 Mearns and Hutchinson;* Butig Mountains, *Mearns s. n.*

Geographical range.—Java.

The type specimen of *Selanginella debilis* (Bory) Spring is not that in Delessert Herbarium as stated in Journ. Bot. 69 (1931) 256, but a specimen in Herbarium Paris which is *Selaginella tenera* (Hk. and Gr.) Spring.

Selaginella lanceolata Warb., from Celebes, and *Selaginella carnea* v. A. v. R., from New Guinea, are closely allied to this species.

21. SELAGINELLA ORNATA (Hk. and Gr.) Spring.

Selaginella ornata (Hk. and Gr.) Spring in Bull. Ac. Brux. 10 (1843) 232.

Lycopodium ornatum Hk. and Gr. in Hook. Bot. Misc. 3 (1833) 108.

Selaginella polita Ridley in Journ. Fed. Mal. States Mus. 6 (1915) 202.

Luzon, Nueva Vizcaya Province, Imugan, *Bur. Sci. 14404 McGregor.* Mindoro, Mount Halcon, *Merrill 6020, Bur. Sci. 40560 Ramos and Edaño.*

Geographical range.—Malay Peninsula, Indo-China, Borneo, Java, and Sumatra.

22. SELAGINELLA LLANOSII Hieron. Plate 2, figs. 5–8.

Selaginella Llanosii Hieron. in Elm. Leafl. Phil. Bot. 6 (1913) 2039, (*Llanoïs*).

? *Selaginella calcicola* Hieron. in Hedwigia 51 (1912) 258.

Sibuyan, Magallanes (Mount Giting-Giting), *Elmer 12393* (type). Panay, Capiz Province, Libucao, *Bur. Sci. 35443 Edaño and Martelino.* Biliran, *Bur. Sci. 18913 McGregor.* Bohol, Dimyao, *Bur. Sci. 42995 Ramos.* Mindanao, Zamboanga Province, San Ramon, *Copeland 1562;* Santa Maria, *Bur. Sci. 16415 Reillo.*

Geographical range.—Southern Philippines and perhaps Borneo.

23. SELAGINELLA PHILIPPINA Spring. Plate 2, figs. 9–12.

Selaginella philippina Spring in Bull. Ac. Brux. 10 (1843) 140.

Selaginella Cumingiana Presl, Bot. Bem. (1844) 153, nomen.

Selaginella polyblepharis Warb. in Monsunia 1 (1900) 110, 127.

Selaginella Moseleyi Hieron. in Elm. Leafl. Phil. Bot. 6 (1913) 2034.

Selaginella Vidalii Hieron. in Elm. Leafl. Phil. Bot. 6 (1913) 2032.

Selaginella Hombroni Hieron. in Elm. Leafl. Phil. Bot. 6 (1913) 2037.

Selaginella philippina var. *longiciliata* Hieron. in Elm. Leafl. Phil. Bot. 6 (1913) 2032.

? *Selaginella lagunensis* Hieron. ex Sasaki Cat. Govt. Herb. (1930) 50.

Philippines, without exact locality, *Cuming 1999.* LUZON, Cagayan Province, Peñablanca, *Bur. Sci. 46588 Ramos and Edaño:* Lepanto Subprovince, Cervantes, *Bur. Sci. 7051 Ramos;* Bauco, *Vanoverbergh 1751:* Ifugao Subprovince, Kiangan, *Bur. Sci. 19983, 20031 McGregor;* Banaue, *Topping 873:* Benguet Subprovince, Baguio, *Elmer 8500;* Benguet Road, *Topping 895:* Nueva Vizcaya Province, near Bayombong, *Clemens 7639:* Pangasinan Province, Mount Carysang, *Bur. Sci. 4883 Ramos:* Bataan Province, Lamao River, *Merrill 3118, For. Bur. 255 Whitford;* Mount Mariveles, *Copeland 2108, 2109, Williams 153:* Rizal Province, San Isidro, *For. Bur. 58 Foxworthy:* Laguna Province, Mount Maquiling, *Elmer 17947, Copeland s. n., Bur. Sci. 17237 Robinson, Merrill 6307, Topping 4949;* Los Baños, *Merrill 5113, Copeland 2014, Baker 285, Topping 714, 670, 671;* Mount Banahao, *Bur. Sci. 9784, 9785* Robinson; Pagsanjan, *Copeland s. n., Topping 998:* Batangas Province, Santo Tomas, *Copeland 2001;* Mount Malarayat, near Lipa, *Copeland s. n.:* Tayabas Province, Quinatacutan, *Bur. Sci. 13189 Forworthy and Ramos;* Lucban, *Elmer 9273.* MINDORO, Alag River, *Merrill 6019.* PANAY, Capiz Province, Agsaman, *Bur. Sci. 46174 Edaño:* Panay Province, Dumarao, *Merrill 6699:* Iloilo Province, *Bur. Sci. 18100 Robinson;* Tigom River, *Bur. Sci. 18044 Robinson;* Iloilo, Suague River, *Bur. Sci. 18147 Robinson.* NEGROS, Luzuriaga, *Bur. Sci. 9936 Robinson;* Dumaguete, *Elmer 10283.* LEYTE, *Wenzel 431.* SAMAR, Sinampigan, *Bur. Sci. 17636 Ramos.* MINDANAO, Davao Province, Todaya (Mount Apo), *Elmer 11722a:* Agusan Province, Bunaoan, *Weber 1201:* Zamboanga Province, Sax River, *Merrill 8226;* Sibulan River, *Copeland 975.*

Geographical range.—Philippines.

Hieronymus makes four species here and has left five additional manuscript names; the species certainly varies in the length and ciliation of the leaves, but I do not think that the characters are sufficiently constant for specific segregation. This species appears to have a characteristic habitat: *Whitford 255* says "on wet rocks by streams," *Copeland 2001* "wet creek-bank." The plants seem to grow closely matted together, and variations in the wetness of the habitat may account for the variability of the species.

Selaginella polyblepharis Warb. was collected by Wichura at "Machaichai," near Manila; I have seen a fragment in Herb. Kew, labeled "Luzon, Wichura 1931."

24. SELAGINELLA MYOSUROIDES (Klf.) Spring.

Selaginella myosuroides (Klf.) SPRING in Bull. Ac. Brux. 10 (1843) 232.

Lycopodium myosuroides KAULF., Enum. Fil. (1824) 19.

LUZON, Benguet Subprovince, Sablang, *Bur. Sci. 12703 Fenix:* Zambales **Province, Olongapo,** *For. Bur. 5825, 5827 Curran;* Anuling, *Bur. Sci. 44570 Ramos and Edaño:* Bulacan Province, near Norzagaray, *Yoder 4:* Bataan Province, Lamao Forest Reserve, *Copeland 26;* Lamao River, *Copeland 2110, Merrill 3127, 3782;* Mount Mariveles, *Copeland 2106, Williams 75, Topping 809;* Dinalupijan, *Merrill 1605:* Rizal Province, Bosoboso, *For. Bur. 3353 Ahern's collector, Bur. Sci. 16955 Ramos, 19254 Reillo, Loher 14497, 14508, Topping 1042;* Montalban, *Merrill 6239, Bur. Sci. 9541 Robinson;* San Andales, *Bur. Sci. 48850 Edaño;* Antipolo, *Topping 627;* Cueva, *Loher 1143;* Malapad na Bató, *Bur. Sci. 11842 Robinson:* Tayabas Province, Mount Binuang, *Bur. Sci. 28692 Ramos and Edaño.*

Geographical range.—Northern and central Luzon.

The stolons, which are very characteristic of this species, are sometimes broken off, when it resembles *Selaginella Eschscholzii* Hieron. The type was localized "insula Manilla, Chamisso."

25. SELAGINELLA ARISTATA Spring. Plate 2, figs. 13–16.

Selaginella aristata SPRING in Bull. Ac. Belg. 10 (1843) 232.

Selaginella Pickringii HIERON. in Elm. Leafl. Phil. Bot. 6 (1913) 2046.

Lycopodium remotifolium DESV. in Ann. Soc. Linn. Par. 6 (1827) 190.

Selaginella myosuroides "Spring;" BRACK., U. S. Expl. Exped. (1854) 338.

Selaginella aristata brevifolia HIERON. in Elm. Leafl. Phil. Bot. 6 (1913) 2045.

Selaginella aristata obtusifolia HIERON. in Elm. Leafl. Phil. Bot. 6 (1913) 2046.

Philippines, *Cuming 1996, Commerson,* Herb. Desvaux. LUZON, Cagayan Province, Abulug River, *Weber 1578:* Ilocos Norte Province, Bangui, *Bur. Sci. 27666 Ramos:* Benguet Subprovince, Bontoc Trail, *Clemens 7689;* Batan, *Bur. Sci. 5892 Ramos;* Sablang, *Bur. Sci. 12641, 12763 Fenix;* Mount Data, *Copeland 1911:* Bataan Province, Lamao Forest Reserve, *Copeland 25:* Rizal Province, Montalban, *Copeland s. n.:* Cavite Province, Mendez Nuñez, *Bur. Sci. 1362 Mangubat:* Laguna Province, Los Baños (Mount Maquiling), *Elmer 17963, Copeland 2015, Brackenridge 15, Topping 661, 938, Serviñas 16868, Bur. Sci. 17169 Robinson;* Pagsanjan, *Copeland 10, 1988;* Calauan, *Bur. Sci. 12413,*

12477 McGregor: Batangas Province, Ambulong, *Marvin s. n.:* Sorsogon Province, Irosin (Mount Bulusan), *Elmer 16958.* ROMBLON, *Elmer 12171.* PANAY, Iloilo Province, Salug River, *Bur. Sci. 18102 Robinson;* Ulian, Atimonan River, *Bur. Sci. 18163 Robinson.* NEGROS, Dumaguete, *Elmer 9593, 9673.* LEYTE, Dagami, *Wenzel 433.* MINDANAO, Zamboanga, San Ramon, *Copeland 1591a, 1559, 717:* Surigao Province, Surigao, *Wenzel s. n.;* Sindangan Bay, *For. Bur. Mearns:* Agusan Province, Agusan River, *Weber 1022.*

Geographical range.—Reported from Java.

Copeland notes on one of his labels "bluish when fresh."

26. SELAGINELLA ESCHSCHOLZII Hieron.

Selaginella Eschscholzii HIERON. in Elm. Leaf. Phil. Bot. 6 (1913) 2041.

Selaginella benguetensis HIERON. in Elm. Leafl. Phil. Bot. 6 (1913) 2043.

Selaginella Wormskioldii HIERON. in Elm. Leafl. Phil. Bot. 6 (1913) 2064.

LUZON, Kalinga Subprovince, Lubuagan, *Bur. Sci. 37479 Ramos and Edaño:* Bontoc Subprovince, Mount Polis, *Bur. Sci. 37709 Ramos and Edaño:* Benguet Subprovince, *Merrill 7733, 7736;* Baguio, *Elmer 8395, 14267, Copeland 1911a, Merrill 7729;* Mount Pulog, *For. Bur. 16323 Curran, Merrill, and Zschokke, Bur. Sci. 8877 McGregor, Clemens s. n., Merrill 6391;* Mount Singakalsa, *Bur. Sci. 82445 Quisumbing and Sulit;* Pauai, *Bur. Sci. 31865 Santos;* Mount Tonglon, *Topping 1207.*

Geographical range.—Mountains of northern Luzon.

27. SELAGINELLA BIFORMIS A. Br.

Selaginella biformis A. BR. ex Kuhn Fil. Afr. (1868) 189 nomen; Kuhn Forsch. Gazette (1889) 17, 19.

Selaginella cupressina SPRING in Mem. Ac. Roy. Belg. 24 (1850) 113; BRACK., U. S. Expl. Exped. (1854) 336.

Selaginella flagellifera BULL., Cat. (1886) 9.

Selaginella hirticaulis WARB. in Monsunia 1 (1900) 103, 114.

Philippines, without exact locality, *Cuming 2016.* LUZON, Apayao Subprovince, Mount Abayawan, *Bur. Sci. 14544 Ramos;* Sitio Viola, *For. Bur. 19597 Curran;* Mount Tabuan, *Bur. Sci. 77218 Ramos;* summit of Mount Caboloan, *Bur. Sci. 78737 Edaño:* Benguet Subprovince, *Merrill 7777, 7778, 7797;* Mount Tonglon, *Topping 1196;* Baguio, *Elmer 6525, Bur. Sci. 11991 Robinson, Topping 257, 332, Bur. Sci. 46491 Rivera:* Nueva Vizcaya Province, Noso, *Bur. Sci. 20069, 20077 McGregor:* Pangasinan Province, Mount San Isidro, *Bur. Sci. 29859 Fénix:* Zambales

Province, Mount Tapulao, *For. Bur. 8143 Curran and Merritt:* Pampanga Province, Mount Abu, *For. Bur. 1934 Foxworthy;* Mount Pinatubo, *Elmer 22160:* Bulacan Province, Angat, *For. Bur. 34112, 34184 Ramos and Edaño:* Bataan Province, Lamao River, *Merrill 3792, Williams 146, Meyer 2174, For. Bur. 1299 Whitford;* Mount Mariveles, *Leiberg 6156, Loher 1141;* crater of Mount Mariveles, *Copeland 2105:* Rizal Province, without locality, *For. Bur. 139 Forworthy;* Mount Canumay, *Bur. Sci. 13750 Ramos;* Mount Susong Dalaga, *Bur. Sci. 29379 Ramos and Edaño:* Laguna Province, Mount Maquiling, *Elmer 18354; Brackenridge 11; Bur. Sci. 13662 Ramos, H. F. Copeland 45;* Pagsanjan, *Copeland, Topping 996:* Batangas Province, Dacanlao, *Bur. Sci. 22404 Ramos; For. Bur. 50 Mearns:* Sorsogon Province, Irosin (Mount Bulusan), *Elmer 16854.* NEGROS, Oriental Negros Province, Canlaon Volcano, *Merrill 6937;* Dumaguete, *Elmer 9595, 9671.* MINDANAO, Zamboanga Province, San Ramon, *Copeland 1562a:* Agusan Province, Cabadbaran (Mount Urdaneta), *Elmer 13942, Weber 1198:* Bukidnon Province, Sumilao, *Bur. Sci. 15744 Fenix.*

Geographical range.—Indo-Malayan.

Warburg, Monsunia p. 104, gives the reference "Ges. nat. Fr. 1863" for *Selaginella biformis,* but I can find no mention of the species on page 8, which is presumably the page intended. Perhaps Bull's horticultural name should be adopted.

28. **SELAGINELLA POLYURA Warb.**

Selaginella polyura WARB. in Monsunia 1 (1900) 104, 116.
Selaginella striolata WARB. in Monsunia 1 (1900) 104, 116.
Selaginella Merrillii v. A. v. R. in Bull. Jard. Bot. Buit. II 1 (1911) 21.

Philippines, without exact locality, *Jagor 858* (not seen). LUZON, Apayao Subprovince, Mount Sulu, *Bur. Sci. 28420 Fenix:* Lepanto Subprovince, Bagnen, *Copeland 1911b;* Mount Masapilid, *Bur. Sci. 37882 Ramos and Edaño:* Ifugao Subprovince, Mount Polis, *Bur. Sci. 19811 McGregor:* Nueva Vizcaya Province, Caraballo Mountains, *Loher 13750; Merrill 251:* Isabela Province, Mount Moises, *Clemens 16545:* Bataan Province, Lamao River, *Merrill 3239;* Mount Mariveles, *Copeland 58:* Camarines Sur Province, Mount Isarog, *Bur. Sci. 76544 Edaño:* Pampanga Province, Mount Arayat, *Topping 496:* Rizal Province, Mount Tokduanbanoy, *Bur. Sci. 48658 Ramos and Edaño:* Albay Province, Mayon Volcano, *Bur. Sci. 75702 Ramos and Edaño.* MINDORO, Mount Halcon, *Whitehead s. n., Merrill 6015.* NEGROS,

Oriental Negros Province, Mount Canlaon, *Merrill 6935;* Mount Silay, *For. Bur. 1530 Whitford;* Dumaguete (Cuernos Mountains), *Elmer 9437.* LEYTE, Jaro, *Wenzel 787, 789.* MINDANAO, Mount Dagatpan, *Warburg 14191* (not seen): Davao Province, Mount Apo, *Hachisuka s. n., Clemens 15709;* Mount Malindang, *For. Bur. 4630 Mearns and Hutchinson:* Zamboanga Province, San Ramon, *Copeland 1464a:* Bukidnon Province, Tangkulan, *Bur. Sci. 39064 Ramos and Edaño.* CAMIGUIN DE MINDANAO, *Bur. Sci. 14765 Ramos.* SULU, *Burbidge s. n.* JOLO, *Clemens 9350.*

It is difficult to separate this species from the next (of which it is probably a form) but in addition to the characters given in the key, the stems of *Selaginella polyura* are generally more slender and the terminal branchlets longer, the lateral leaves, in a dry state, curl near the apex instead of from the base, forming a broad U instead of a V; they are also more silvery beneath.

Selaginella Merrillii v. A. v. R. was based on *Merrill 251,* but was later reduced to *Selaginella polyura* Warb. by van Alderwerelt van Rosenburgh in Malayan Fern Allies (1915) 734.

29. SELAGINELLA PELTATA Presl.

Selaginella peltata PRESL, Bot. Bem. (1844) 152.
Selaginella bellula CES. in Atti R. Ac. Napoli 7 (1876) 38.
Selaginella involvens bellula (Ces.) HIERON. in Hedw. 50 (1910) 4.
Selaginella microstachya WARB. in Monsunia 1 (1900) 104, 116.
Selaginella Warburgii HIERON. in Elm. Leafl. Phil. Bot. 6 (1913) 1988.
Lycopodium microstachyum DESV. ex Poir. Encycl. (1814) 554.
Selaginella microstachya (Desv.) HIERON. in Elm. Leafl. Phil. Bot. 6 (1913) 1988.

Philippines, without exact locality, *Cuming 1998.* LUZON, Apayao Subprovince, Mount Sulu, *Bur. Sci. 28400 Fenix;* Mount Caua, *Bur. Sci. 38054 Ramos and Edaño:* Benguet Subprovince, without locality, *For. Bur. 2835 Mearns, Merrill 7668;* Baguio, *Topping, 223, Elmer 8384;* Mount Santo Tomas, *For. Bur. 66 Mearns:* Nueva Vizcaya Province, Noso to Imugan, *Bur. Sci. 20096 McGregor:* Isabela Province, Mount Moises, *Clemens 16543:* Nueva Ecija Province, without locality, *For. Bur. 12308 Foxworthy:* Zambales Province, Mount Pinatubo, *Clemens 17336, Elmer 22329:* Pampanga Province, Mount Arayat, *Merrill 3825:* Bataan Province, Mount Mariveles, *Topping 374, 387, Copeland 2056, 2066;* Lamao River, *For. Bur. 173 Whitford, Copeland 24:* Rizal Province, Tanay, *Merrill 2311;* Bosoboso, *Bur. Sci. 1500*

Ramos; Mount Susong-Dalaga, *Bur. Sci. 29363 Ramos and Edaño;* Montalban, *Loher 12089, 14708:* Laguna Province, Mount Maquiling, *H. F. Copeland 60, Elmer 17744,* Siniloan Trail, *Bur. Sci. 9494 Robinson:* Tayabas Province, Atimonan, *For. Bur. 721 Whitford, Topping 1320;* Quinatacutan, *For. Bur. 13183 Foxworthy and Ramos;* Lucban, *Elmer 9272;* Binuang, *Bur. Sci. 28546 Ramos and Edaño;* Infanta, *Bur. Sci. 9388 Robinson:* Albay Province, Mayon Volcano, *Bur. Sci. 75702 Ramos and Edaño:* Sorsogon Province, Irosin (Mount Bulusan), *Elmer 16068.* MINDORO, Puerto Galera, *Kienholz 15192;* Binabay River, *Merrill 6017.* PANAY, Antique Province, Culasi, *Bur. Sci. 32336 McGregor:* Iloilo Province, *Bur. Sci. 18171 Robinson;* Jamindan, *Bur. Sci. 30852.* LEYTE, Dagami, *Wenzel 489, 492;* JARO, *Wenzel 850, 1030.* BOHOL, Bilar, *Bur. Sci. 43012 Ramos.* MINDANAO, Davao Province, Baroring Cañon, Todaya, *Copeland 1454;* Mount Apo, *Elmer 11619:* Agusan Province, Cabadbaran (Mount Urdaneta), *Elmer 13596:* Cotabato Province, Datto, *Weber:* Zamboanga Province, Malangas, *Bur. Sci. 37008 Ramos and Edaño; Merrill 8227.* JOLO, Mount Dajo, *Merrill 5323.*

Geographical range.—Malay Peninsula and Borneo.

30. SELAGINELLA MÖLLENDORFFII Hieron.

Selaginella Möllendorffii HIERON. in Engl. and Prantl Nat. Pfl. 1 (1901) 680; in Hedw. 41 (1902) 178.
Selaginella subcaulescens HAYATA, Ic. Pl. Formos. 7 (1918) 99.
Selaginella Hayatana KUMMERLE in Mag. Bot. Lapok 26 (1928) 100.

BATAN, Batanes Province, *Bur. Sci. 10198 McGregor, Bur. Sci. 80755 Ramos;* Santo Domingo de Basco, *Bur. Sci. 3617 Fenix.* LUZON, Cagayan Province, Pinakanawan River, Peñablanca, *Bur. Sci. 77182 Ramos:* Ilocos Norte Province, Bangui, *Bur. Sci. 43521, 43573 McGregor.*

Geographical range.—China, Formosa, and Indo-China.

31. SELAGINELLA MAGNIFICA Warb.

Selaginella magnifica WARB. in Monsunia 1 (1900) 103, 114, t. 8 A.

MINDANAO, Davao Province, Todaya (Mount Apo), *Elmer 11276:* Agusan Province, Cabadbaran (Mount Urdaneta), *Elmer 13364;* Agusan Valley, *Merrill 667, Weber 1203;* Mount Dagatpan, *Warburg 14199* (type not seen).

Geographical range.—Mindanao.

Bonaparte's *Selaginella magnifica* from Indo-China (Notes Ptérid. 14: 192) is a distinct species of *Selaginella Rolandi-Principis* Alston.

32. SELAGINELLA PROCERA Alston.

Selaginella procera ALSTON in Journ. Bot. 72 (1934) 227.

LUZON, Camarines Province, Kamagon River, *Bur. Sci. 75786 Edaño;* Kolago River, *Bur. Sci. 76525 Edaño.* CATANDUANES, Mount Mariguidon, *Bur. Sci. 30449 Ramos and Edaño.*

Geographical range.—Southern Luzon and Catanduanes.

33. SELAGINELLA ELMERI Hieron. Plate 1, figs. 1–4.

Selaginella Elmeri HIERON. in Fedde Repert. 10 (1911) 46.
Selaginella Quadrasii HIERON. in Fedde Repert. 10 (1911) 114.

CATANDUANES, Bato Trail to Viga, *Bur. Sci. 75661 Ramos and Edaño.* SAMAR, Yabong, *Bur. Sci. 17560 Ramos;* Catubig River, *Bur. Sci. 54884 Edaño;* Loquilocon, *Bur. Sci. 43739, 43743 McGregor.* LEYTE, Dagami *Wenzel 377;* Palo, *Elmer 7070* (type of *S. Elmeri*); Cabalian, *Bur. Sci. 41504 Ramos.* MINDANAO, Surigao Province, Placer, *Wenzel 3370;* without exact locality, *Quadras* (not seen); Agusan Province, Cabadbaran (Mount Urdaneta), *Elmer 13407.*

Geographical range.—Southern Philippines.

Selaginella Quadrasii Hieron. seems to be simply a large form of *Selaginella Elmeri;* there are several intermediates even in the small series of specimens enumerated here.

34. SELAGINELLA LATIFRONS Warb.

Selaginella latifrons WARB. in Monsunia 1 (1900) 106, 120.

LUZON, *Jagor* (type, fragment in Kew Herbarium): Camarines Province, Maagnas, *Bur. Sci. 6349 Robinson* (fragment in Kew Herbarium). CATANDUANES, *Bur. Sci. 30577 Ramos.*

Geographical range.—Southern Luzon and neighboring islands.

35. SELAGINELLA AGUSANENSIS Hieron.

Selaginella agusanensis HIERON. in Elm. Leafl. Phil. Bot. 6 (1913) 1998.

MINDANAO, Agusan Province, Cabadbaran (Mount Urdaneta), *Elmer 14194* (type).

Geographical range.—Confined to Mindanao.

Doubtfully distinct from the last species.

36. SELAGINELLA COPELANDII Hieron.

Selaginella Copelandii HIERON. in Fedde Repert. 10 (1911) 106.

MINDANAO, Zamboanga Province, San Ramon, *Copeland 1563* (type); Santa Maria, *Bur. Sci. 16433 Reillo:* Agusan Province, Cabadbaran, *Weber 1200;* Sax River, *Williams 2242.*

Geographical range.—Mindanao.

The affinity of this species is with *Selaginella latifrons*, but the median leaves are more strongly aristate.

37. SELAGINELLA RAMOSII Hieron.

Selaginella Ramosii HIERON. in Fedde Repert. 10 (1911) 52.

BATAN, Batanes Province, Mount Iraya, *Bur. Sci. 80131 Ramos.* LUZON, Tayabas Province, Malicboy, *Bur. Sci. 26916 Edaño;* Atimonan, *Merrill 3998:* Rizal Province, Tanay, *Merrill 2312;* Balacbac, *Loher 13016, 13039.*

Geographical range.—Northern Luzon.

Hieronymus quotes *Elmer 6152* and *Fenix 12621* for *Selaginella Ramosii* ? = *Tanay* and *Jagorii.*

38. SELAGINELLA NEEI Hieron.

Selaginella Neei HIERON. in Fedde Repert. 10 (1911) 48.

LUZON, Benguet Subprovince, Sablan, *Elmer 6152, Topping 1110:* Nueva Vizcaya Province, near Dupax, *Bur. Sci. 14269 McGregor.*

Geographical range.—Northern Luzon.

Hieronymus quotes *Elmer 6152* and *Fenix 12621* for *Selaginella Neei,* both from Sablan.

39. SELAGINELLA FÉNIXII Hieron.

Selaginella Fénixii HIERON. in Fedde Repert. 10 (1911) 98.
Selaginella Gregoryi HIERON. in Fedde Repert. 10 (1911) 102.

LUZON, Apayao Subprovince, without locality, *Bur. Sci. 13886 Ramos;* Mount Narig, Abulug River, *Weber 1536:* Isabela Province, Mount Cresta, *Bur. Sci. 77195 Ramos:* Cagayan Province, Peñablanca, *Bur. Sci. 46614 Ramos and Edaño:* Nueva Vizcaya Province, near Dupax, *Bur. Sci. 14268 McGregor:* Benguet Subprovince, Sablan, *Bur. Sci. 12702 Fénix* (type of *S. Fenixii*); between Baguio and Sablan, *Bartsch 249:* Tayabas Province, Malicboy, *Bur. Sci. 26916 Edaño:* between Malicboy and Atimonan, *Topping 1319:* Camarines Norte Province, Paracale, *Bur. Sci. 33782 Ramos and Edaño:* Sorsogon Province, Mount Bulusan, *Elmer 16091.* POLILLO, *Bur. Sci. 10300 McGregor.* ALABAT, *Bur. Sci. 48371 Ramos and Edaño.* BOHOL, *Bur. Sci. 43018 Ramos.*

Geographical range.—Luzon and adjacent islands.

Hieronymus quotes *Curran 9542, Gregory 145,* and *McGregor 10300* for *Selaginella Gregoryi.*

40. SELAGINELLA JAGORII Warb.

Selaginella Jagorii WARB. in Monsunia 1 (1900) 104, 116.
Selaginella banajaoensis HIERON. in Fedde Repert. 10 (1911) 45.

Selaginella Meyenii HIERON. in Fedde Repert. 10 (1911) 50.
Selaginella sibuyanensis HIERON. in Fedde Repert. 10 (1911) 97.
Selaginella fallax HIERON. in Fedde Repert. 10 (1911) 104.

LUZON, *Jagor 857* (fragment of type of *Selaginella Jagorii!* in Kew Herbarium). Manila, *Meyer* (fragment of type of *Selaginella Meyenii!* in Kew Herbarium): Bataan Province, Lamao River, Mount Mariveles, *Merrill 3241, 7609, For. Bur. 168 Whitford, Copeland 2107, Topping 364, 436, 837, Borden 2382:* Laguna Province, Los Baños (Mount Maquiling), *Copeland 12, Bur. Sci. 17034 Robinson;* Mount Banajao, *Bur. Sci. 9757 Robinson* (type of *Selaginella banajaoensis*), *Merrill 7505;* San Antonio, *Bur. Sci. 14983 Ramos:* Tayabas Province, without locality, *For. Bur. 626 Whitford;* Rio Sic Sic, Guinayangan, *Bur. Sci. 13215 Ramos:* Camarines Sur Province, Mount Potianay, *Bur. Sci. 75788 Edaño.* SIBUYAN, Magallanes (Mount Giting-Giting), *Elmer 12516* (type of *Selaginella sibuyanensis*): Sorsogon Province, Mount Bulusan, *16159 Elmer.*

Geographical range.—Central and southern Luzon and Sibuyan.

Hieronymus quotes *Topping 364, 436, Copeland 265, 2104, 2107, For. Bur. 168 Whitford, Merrill 3241* all from Mount Mariveles for *Selaginella fallax. Borden 2382* quoted for *Selaginella Meyenii* was also from Mount Mariveles. A plant from Mount Bulusan (Sorsogon), *Elmer 16159, 16149,* and *Bur. Sci. 23691 Ramos* with larger aristæ probably belongs to this species.

41. SELAGINELLA HALCONENSIS Hieron.

Selaginella halconensis HIERON. in Fedde Repert. 10 (1911) 108.
Selaginella Sancti-Antonii HIERON. in Fedde Repert. 10 (1911) 100.
Selaginella paraguana HIERON. in Fedde Repert. 10 (1911) 109.
Selaginella infantensis HIERON. in Fedde Repert. 10 (1911) 111.
Selaginella Toppingii HIERON. in Fedde Repert. 10 (1911) 112.

LUZON, Tayabas Province, Infanta, *Bur. Sci. 9318 Robinson:* Laguna Province, San Antonio, *Bur. Sci. 12083 Ramos* (type of *Selaginella Sancti-Antonii*); Mount Maquiling, *Topping 911* (type of *Selaginella Toppingii*). MINDORO, Mount Halcon, *Merrill 6018* (fragment of type of *Selaginella halconensis* in Kew Herbarium). PALAWAN, Iwahig River, *Merrill 755* (type of *Selaginella paraguana*); Mount Capoas, *Merrill 9549.*

42. SELAGINELLA AENEA Warb.

Selaginella aenea WARB. in Monsunia 1 (1900) 104, 115.
Selaginella Bacanii HIERON. in Fedde Repert. 10 (1911) 48.

LUZON, Cagayan Province, Pamplona, *Bur. Sci. 7559 Ramos* (type of *S. Bacanii*) : Tayabas Province, Casiguran, *Bur. Sci. 45411 Ramos and Edaño.* MINDANAO, San Ramon, *Copeland 1591;* Mount Dagatpan, *Warburg 14192* (fragment at Kew Herbarium) ; Zamboanga Province, *Merrill 8216.*

Geographical range.—Confined to the Philippines.

Selaginella cupressina var. *aristulata* Hieron. should probably be placed here.

43. SELAGINELLA PRESLIANA Spring.

Selaginella Presliana SPRING in Bull. Ac. Brux. 10 (1843) 137.
Selaginella pteryphyllos SPRING in Mem. Acad. Belg. 24 (1850) 162.
Lycopodium microstachyum PRESL, Rel. Haenk. (1825) 80 non Desv.
Selaginella myosuroides "(Klf.)"; PRESL, Bot. Bem. (1844) 153 non *Lycopodium myosuroides* Klf.

Philippines, without exact locality, *Cuming 2017.* LUZON, *Haenke s. n.:* Cagayan Province, Mount Babatugin, *Bur. Sci. 79634 Edaño:* Isabela Province, Mount Moises, *Clemens 16545:* Tayabas Province, Mount Cadig, *Bur. Sci. 25409 Yates.*

Geographical range.—Northern Luzon.

44. SELAGINELLA LUZONENSIS Hieron.

Selaginella luzonensis HIERON. in Engl. and Prantl Nat. Pfl. 1 (1901) 681; in Hedwigia 41 (1902) 181.

LUZON, *Jagor 806* (fragment in Kew Herbarium!) ; Camarines Sur Province, Maagnas, *Bur. Sci. 6316 Robinson.* BILIRAN, *Bur. Sci. 18740 McGregor.* CATANDUANES, Mount Nagpakdit, *Bur. Sci. 75658 Ramos and Edaño.*

Geographical range.—Southern Luzon and adjacent islands.

45. SELAGINELLA FLABELLOIDES Warb.

Selaginella flabelloides WARB. in Monsunia 1 (1900) 105, 118.

LUZON, Isabela Province, Digamas, *Warburg 11977* (fragment in Kew Herbarium!) : Tayabas Province, Guinayañgan, *Bur. Sci. 13228 Ramos.* BOHOL, Bilar, *Bur. Sci. 43018 Ramos.* PALAWAN, Mount Mantalingahan, *Bur. Sci. 77931 Edaño.* CAMIGUIN, Balatubat, *Bur. Sci. 79624 Edaño.* MINDANAO, Zamboanga Province, Sax River, *Williams 2243:* Lanao Province, Camp Keithley, Lake Lanao, *Clemens 92.*

Geographical range.—Confined to the Philippines.

Doubtfully distinct from *Selaginella cupressina* (Willd.) Spring.

46. SELAGINELLA CUPRESSINA (Willd.) Spring.

Selaginella cupressina (Willd.) SPRING in Flora 21 (1838) 211.
Lycopodium cupressinum WILLD., Sp. Pl. 5 (1810) 42.
Lycopodium cupressiforme "Willd.;" DESV. in Mem. Soc. Linn. Par. 6 (1827) 187 sphalm.

Lycopodium pennula DESV. in Mem. Soc. Linn. Par. 6 (1827) 187.
Selaginella pennula (Desv.) SPRING in Bull. Ac. Brux. 10 (1843) 137.
Selaginella quadrangula PRESL in Abh. Böhm. Ges. Wiss. 3 (1844) 581.
Selaginella Brausei HIERON. in Fedde Repert. 10 (1911) 41.
Selaginella leytensis HIERON. in Fedde Repert. 10 (1911) 42.

Philippines, without exact locality, *Cuming 2000*, in Herbarium Desvaux, *Haenke s. n.* LUZON, Cagayan Province, Claveria, *Bur. Sci. 7567 Ramos, Bur. Sci. 10737 McGregor;* Sitio Viola, *For. Bur. 19585 Curran;* Abulug River, *Weber 1537:* Apayao Subprovince, *Bur. Sci. 28167 Fénix;* Rolo, *Vanoverbergh 17734:* Isabela Province, Cordon, *Bur. Sci. 7998 Ramos:* Nueva Vizcaya Province, near Dupax, *Bur. Sci. 14265, 14267 McGregor:* Nueva Ecija Province, Caraballo Sur, *Merrill 209:* Rizal Province, Bosoboso, *For. Bur. 2689, 3422 Ahern's collector, Loher 14808;* Balacbac, *Loher 13039;* Paning-tingan, *Loher 13499;* Bosoboso, *Bur. Sci. 958 Ramos:* Laguna Province, Paete, *Bur. Sci. 22836 McGregor;* Siniloan-Infanta trail, *Bur. Sci. 22968 McGregor;* Los Baños (Mount Maquiling), *Merrill 620, Copeland s. n., Bur. Sci. 17326 Robinson and Brown, For. Bur. 26056 Mabesa, Bur. Sci. 13720 Ramos, Topping 726, 940, 496;* Pagsanjan, *Copeland 1989;* San Antonio, *Bur. Sci. 20576 Ramos:* Tayabas Province, Malicboy, *Merrill 2444;* Lucban, *Elmer 7917;* Atimonan, *Topping 1304:* Camarines Norte Province, Paracale, *Bur. Sci. 33584 Ramos and Edaño:* Camarines Sur Province, Mount Isarog, *Bur. Sci. 22040 Ramos:* Sorsogon Province, Irosin (Mount Bulusan), *Elmer 16094.* MINDORO, Puerto Galera, *Cruz s. n.;* Paluan, *Bur. Sci. 39667 Ramos.* POLILLO, *Bur. Sci. 6907 Robinson.* PALAWAN, Mount Matalingajan, *Bur. Sci. 77932.* PANAY, Capiz Province, Libucao, *Bur. Sci. 35441 Martelino and Edaño.* NEGROS, Dumaguete, *Elmer 9603.* LEYTE, *Wenzel 1175;* Dagami, *Wenzel 379;* Tacloban, *Copeland 23;* Palo, *Elmer 7058.* BOHOL, Bilar, *Bur. Sci. 43001 Ramos.* MINDANAO, Davao Province, Sibulan, *Copeland 1306, 1449;* Todaya (Mount Apo) *Elmer 11212:* Surigao Province, Surigao, *Wenzel 3372;* Placer, *Wenzel 3105, 3139, 3373:* Zamboanga Province, Bangaan, *For. Bur. 11531 Whitford:* Agusan Province, Cabadbaran (Mount Urdaneta), *Elmer 13355;* Butuan, *Weber 1197;* Malangas, *Bur. Sci. 36904 Ramos and Edaño:* Zamboanga Province, Sax River, *Williams 2243.* BASILAN, *Bur. Sci. 16196 Reillo.*

Geographical range.—Amboina.

Willdenow's locality Bourbon is doubtless a mistake as stated by Kuhn (Forsch. Gazette p. 18).

ILLUSTRATIONS

PLATE 1

FIG. 1. *Selaginella Elmeri* Hieron., habit, × 0.75.
2. *Selaginella Elmeri* Hieron., cone, × 10.
3. *Selaginella Elmeri* Hieron., leaves from above, × 10.
4. *Selaginella Elmeri* Hieron., leaves from beneath, × 10.

PLATE 2

FIG. 1. *Selaginella intertexta* Spring, habit, × 1.
2. *Selaginella intertexta* Spring, cone from beneath, × 10.
3. *Selaginella intertexta* Spring, leaves from above, × 10.
4. *Selaginella intertexta* Spring, leaves from below, × 10.
5. *Selaginella Llanosii* Hieron., habit, × 1.
6. *Selaginella Llanosii* Hieron., cone from beneath, × 10.
7. *Selaginella Llanosii* Hieron., leaves from beneath, × 10.
8. *Selaginella Llanosii* Hieron., leaves from above, × 10.
9. *Selaginella philippina* Spring, habit, × 1.
10. *Selaginella philippina* Spring, cone from beneath, × 10.
11. *Selaginella philippina* Spring, leaves from above, × 10.
12. *Selaginella philippina* Spring, leaves from beneath, × 10.
13. *Selaginella aristata* Spring, cone from beneath, × 10.
14. *Selaginella aristata* Spring, leaves from beneath, × 10.
15. *Selaginella aristata* Spring, leaves from above, × 10.
16. *Selaginella aristata* Spring, habit, × 10.

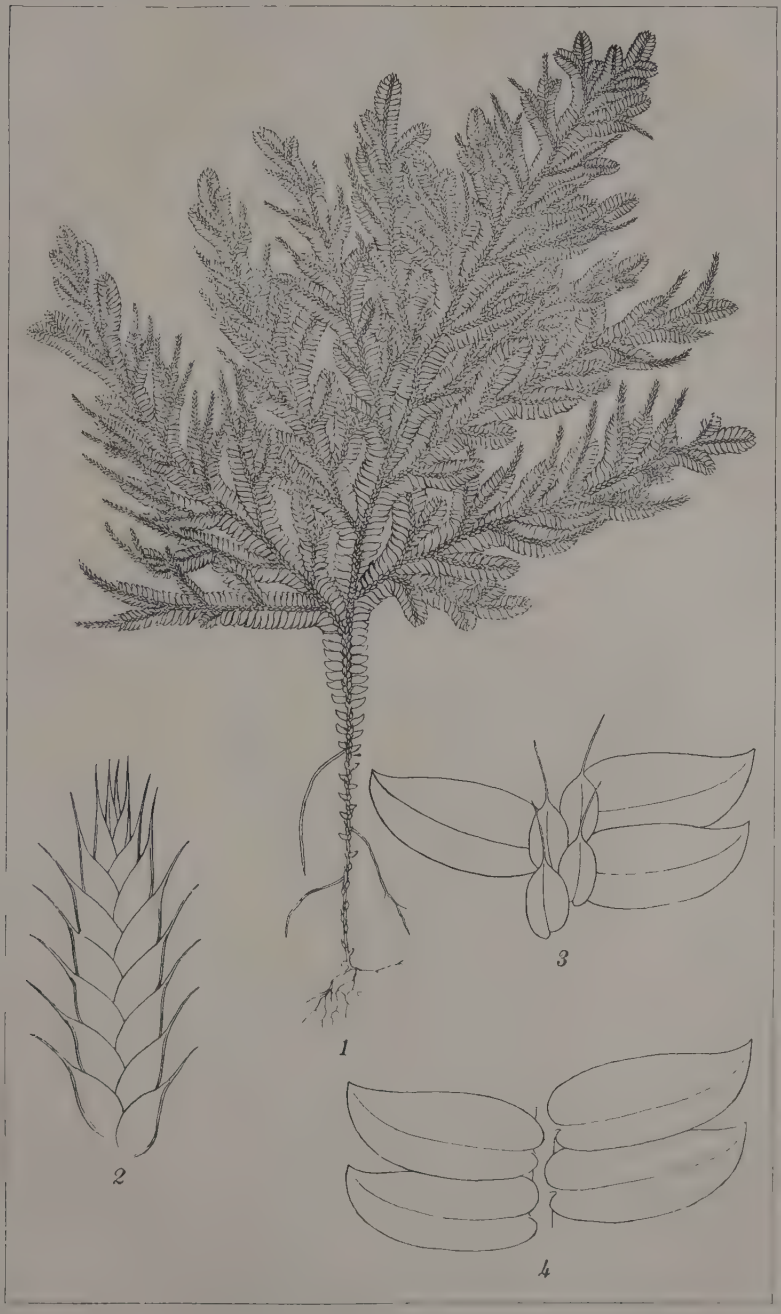

PLATE 1.

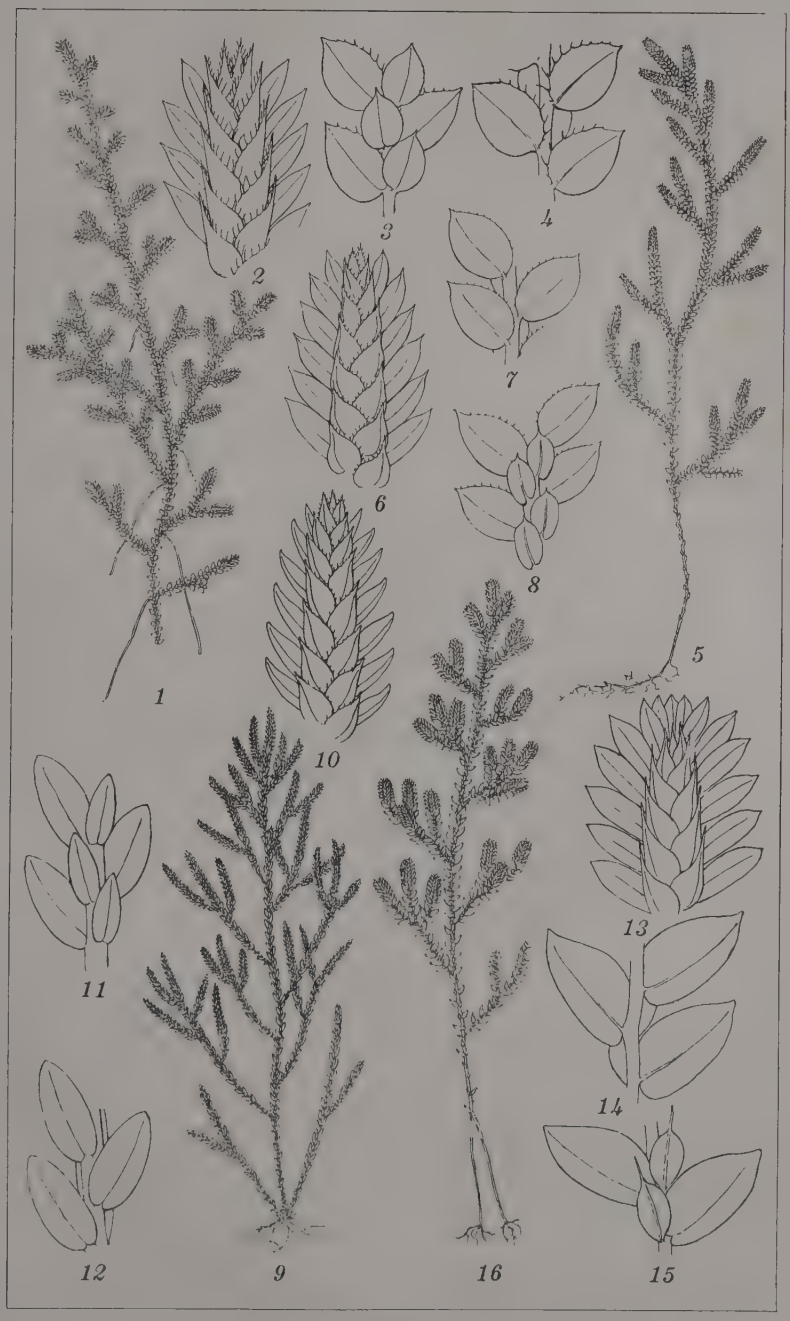

PLATE 2.

NEW OR LITTLE-KNOWN TIPULIDÆ FROM EASTERN ASIA (DIPTERA), XXVIII[1]

By Charles P. Alexander

Of Amherst, Massachusetts

FOUR PLATES

The new species discussed in the present report are chiefly from Kashmir, where they were collected by Miss Vivien R. Hutchinson. A few additional species are from Celebes, collected by Clagg; Java, by Handschin and Walsh; Japan, by Issiki; and China, by Franck, Graham, and Suenson. Except where stated to the contrary in the text, the types of the novelties are preserved in my collection of these flies. I wish to express my deepest appreciation to all of the above-mentioned entomologists, who have aided materially in the progress of this study of the Asiatic Tipulidæ. In order to complete the data, I have included in this paper the descriptions of a few species of the allied family Trichoceridæ, commonly called the winter crane flies.

TRICHOCERIDÆ

TRICHOCERA ALTICOLA sp. nov. Plate 1, fig. 1; Plate 2, fig. 25.

Size very large (wing, female, over 10 millimeters); general coloration uniformly dark gray to blackish gray; antennæ with basal six or seven flagellar segments incrassated, the outer segments suddenly narrowed; knobs of halteres darkened; legs brownish black; wings clear, highly iridescent; stigma conspicuous, elongate, brown, extending the entire length of vein R_{1+2}; R_{2+3+4} shorter than R_{2+3}; R_{1+2} elongate; abdomen uniformly dark brown; cerci with the lower or ventral edge gently emarginate.

Female.—Length, about 9 millimeters; wing, 10.4 by 3.3.

Rostrum gray; palpi black. Antennæ black throughout; basal segment of flagellum long-conical; succeeding five or six segments slightly incrassated, the remainder very slender and somewhat paler than the basal ones. Head dark gray.

[1] Contribution from the entomological laboratory, Massachusetts State College.

Mesonotum uniformly dark gray to blackish gray, without markings. Pleura dark gray. Halteres pale, the knobs infuscated. Legs with the coxæ and trochanters blackish gray; remainder of legs brownish black. Wings (Plate 1, fig. 1) clear, highly iridescent, with a conspicuous, elongate, brown stigmal area extending the entire length of vein R_{1+2}; indications of a much smaller seam on r-m; veins dark brown, the basal third of vein M paler. Macrotrichia of veins short and inconspicuous but well distributed on almost all veins. Venation: R_{2+3+4} shorter than R_{2+3}; R_{1+2} elongate, approximately one-half the length of Rs; cell M_1 nearly twice its petiole; m-cu at fork of M_{3+4}.

Abdomen uniformly dark brown, only the pleural membrane pale. Cerci (Plate 2, fig. 25, *c*) with the lower or ventral edge gently emarginate, not straight as in *simonyi*.

Habitat.—Kashmir.

Holotype, female, Bitzal Nullah, West Karakoram, altitude 14,000 feet, September 2, 1934 (*Hutchinson*).

The only other generally similar species is *Trichocera simonyi* Mik,[2] described from the Tyrolian Alps, at high altitudes (9,350 feet), collected in early October. Apparently this latter species is still known only from the unique female types. The present fly is almost exactly like *simonyi* in size and further agrees in the general features of coloration, but differs evidently in the conspicuous brown stigma of the wings and the distinct structure of the cerci of the ovipositor.

TRICHOCERA GLACIALIS sp. nov. Plate 1, fig. 2; Plate 2, fig. 26.

General coloration dull black, sparsely pruinose; wings subhyaline, with a sparse pale gray pattern, including seams at r-m and beneath the origin of Rs, additional to restricted markings elsewhere; R_{2+3+4} about one-half R_{2+3}; cell M_1 a little longer than its petiole; abdomen distinctly annulated, the tergites pale brown with the caudal borders narrowly dark brown; sternites yellow, the margins narrowly pale; ventromesal lobe of basistyle at apex produced caudad into a slender dusky lobule.

Male.—Length, about 6.5 millimeters; wing, 7.5.

Rostrum brownish gray; palpi black. Antennæ with the scape and pedicel brownish black, the flagellum somewhat darker; flagellar segments beyond the first moderately incrassated, the

[2] Wien. Ent. Zeitung 5 (1886) 5–59.

succeeding segments gradually more slender. Head blackish gray.

Pronotum brownish black, the posterior notum obscure yellow. Mesonotum dull black, sparsely pruinose, without evident markings. Pleura dark brown, the dorsopleural region somewhat paler. Halteres relatively long, pale, the knobs infuscated. Legs with the coxæ pale, more darkened basally; tibiæ and tarsi dark brown. Wings (Plate 1, fig. 2) subhyaline, with a sparse pale gray pattern, including a seam at r-m; on one wing of type with a second area, scarcely separated from the first, lying in outer end of cell R; a large cloud beneath origin of Rs; narrow seams along m-cu and outer end of cell 1st M_2; very small and insignificant clouds at fork of M_{1+2} and at near two-thirds the length of cell R_4; vague indications of a cloud at tip of vein 2d A; stigmal area not darkened; veins brown. Macrotrichia of veins short but abundant. Venation: R_{2+3+4} unusually short, somewhat less than one-half R_{2+3}, the latter a little shorter than subequal to R_{1+2}; basal section of R_5 slightly reduced; cell M_1 a little longer than its petiole; m-cu shortly before fork of M_{3+4}; cell 2d A narrow.

Abdomen distinctly annulated, the tergites pale brown with their caudal margins narrowly dark brown; sternites light yellow, beyond the first segment with the caudal borders narrowly and weakly darkened; subterminal segments more uniformly darkened; hypopygium a little brightened. Male hypopygium (Plate 2, fig. 26) with the ventromesal lobe of basistyle, *b*, unusually stout, the apex truncated and with the outer apical angle further produced caudad into a slender dusky lobule; the lobes of the two sides touch and thus form a contiguous bridge. Dististyle, *d*, distinctly narrowed on a little more than the distal third, gently curved, without a distinctly developed lobule on mesal face. Gonapophyses very long and slender, gradually narrowed to needlelike points.

Habitat.—Kashmir.

Holotype, male, Kerolungma Glacier, Baltistan, altitude 11,000 feet, August 26, 1934 (*Hutchinson*).

By keys to the Holarctic species of *Trichocera*, the present fly runs to *T. annulata* Meigen, from which it differs in the patterned wings and structure of the male hypopygium. On the basis of wing pattern, the fly runs to *T. maculipennis* Meigen, differing conspicuously in the coloration of the body and wings, and in

the structure of the hypopygium, notably the peculiar apical lobule of the basistyles (coxites).

TRICHOCERA ABIETICOLA sp. nov. Plate 1, fig. 3; Plate 2, fig. 27.

General coloration dark brownish gray; legs dark brown, the femoral bases restrictedly obscure yellow; wings with a pale brown tinge, sparsely patterned with pale gray clouds, including areas on anterior cord and beneath origin of Rs; veins P_{2+3+4} and R_{2+3} both relatively long and subequal in length; abdominal tergites dark brown; ventromesal lobe of basistyle contiguous at midline with its mate of the opposite side, its apex obtusely rounded; dististyle subcylindrical, unarmed.

Male.—Length, about 6.5 millimeters; wing, 7.2 to 7.3.

Rostrum dark brown; palpi black. Antennæ black throughout. Head brownish gray.

Mesonotum almost uniformly dark brownish gray, without markings. Pleura dark gray, the dorsopleural region brown. Halteres dusky, the extreme base of stem pale. Legs with the coxæ brownish gray; trochanters pale brown; remainder of legs dark brown, the femoral bases restrictedly obscure yellow. Wings (Plate 1, fig. 3) with a very pale brownish tinge, sparsely patterned with pale gray clouds, including areas on anterior cord, beneath origin of Rs, outer end of cell 1st M_2, fork of M_{1+2} and at near two-thirds the length of vein M_4; stigmal region vaguely washed with pale brown; veins dark brown. Macrotrichia of veins relatively short. Venation: R_{2+3+4} and R_{2+3} subequal and relatively long, each being nearly one-third as long as Rs; R_{2+3} longitudinal in position, not subperpendicular as in some allied species; m-cu shortly before fork of M_{3+4}.

Abdominal tergites dark brown throughout, the basal sternites somewhat paler. Male hypopygium (Plate 2, fig. 27) with the ventromesal lobe of basistyle, *b*, relatively slender, contiguous at midline with its mate of the opposite side to form a bridge, at apex gently rounded. Dististyle, *d*, slender, subcylindrical, or very slightly narrowed outwardly, unarmed at base.

Habitat.—Kashmir.

Holotype, male, Bandapur, altitude 9,000 feet, caught beneath young silver-fir trees, November, 1934 (*Hutchinson*). Paratopotypes, 1 male with type; 1 male, altitude 7,000 feet, November 15, 1934.

The nearest ally of the present species would appear to be *Trichocera glacialis* sp. nov., rather than other somewhat similar forms that are allied to *maculipennis*. Both of these Kashmir

species have the same pale gray wing pattern and uniformly darkened legs, but the present fly is readily told by the venation of the radial field, the unarmed ventromesal lobe of the basistyle, and the uniformly darkened abdomen. *Trichocera punctipennis* Brunetti and some allied forms are very different in their leg pattern, having a narrow but distinct subterminal brown ring on femora, additional to other differences of venation, wing pattern, and structure of the male hypopygium.

TIPULIDÆ

TIPULINÆ

CTENACROSCELIS NIMBUS sp. nov. Plate 1, fig. 4; Plate 2, fig. 28.

Belongs to the *brobdignagius* group; mesonotal præscutum dark brown, with four more grayish brown stripes; posterior border of scutum and scutellum entirely black; mediotergite uniformly gray; pleura yellow, with a dorsal brown stripe; wings strongly tinged with brown, variegated by clearer areas in cells M, Cu, 1st A, and 2d A; abdomen dark brownish gray; hypopygium dark; male hypopygium with the outer dististyle broad, only slightly narrowed outwardly; eighth sternite with a large brush of yellow setæ on each lateral lobe.

Male.—Length, excluding head, about 25 millimeters; wing, 36.5.

Head broken.

Pronotum chiefly light yellow, restrictedly darkened on ventral portion and on propleura. Mesonotal præscutum with the ground color dark brown, with four more grayish brown stripes, the midline broad, more than one-half as wide as either of the intermediate stripes; ground color and stripes becoming less evident and differentiated behind; lateral borders of præscutum broadly light yellow; scutum brownish gray, including the median area, the posterior border and scutellum entirely black; parascutella on posterior half more yellow; mediotergite uniformly gray. Pleura yellow, with a relatively narrow dorsal brown stripe; ventral sternopleurite very weakly darkened. Halteres dusky. Legs with the coxæ and trochanters yellow; femora yellow, the tips rather narrowly but very conspicuously blackened; tibiæ yellow, the tips narrowly and inconspicuously infuscated; tarsi passing through yellow to black. Wings (Plate 1, fig. 4) strongly tinged with brown, variegated by clearer areas across bases of anal cells and near central por-

tion of cell Cu; a conspicuous pale area in outer end of cell M; prearcular region more blackened; stigma and costal region more saturated yellow; restricted obliterative areas along cord; a narrow dark brown seam along m-cu; veins yellowish brown. Venation: R_1 shortly before fork of R_{2+3}, obliterating R_2; vein R_3 somewhat angularly bent at near two-thirds the length; m-cu shortly before fork of M_{3+4}.

Abdomen dark brownish gray; hypopygium dark. Male hypopygium with the ninth tergite (Plate 2, fig. 28, 9*t*) elongate, the caudal margin with a deep U-shaped notch, the lateral lobes subtruncate; abundant setæ on outer two-fifths of tergite, these longer and more numerous on lateral border cephalad of the lobes, the latter with relatively short setæ only. Outer dististyle, *od*, unusually broad, nearly parallel-sided, so the apex is very broad and rounded; distal third of style without setæ; basal setæ more elongate. Inner dististyle, *id*, enlarged at outer end. Eighth sternite, 8*s*, relatively long, the caudal margin deeply notched but with the emargination chiefly filled with pale membrane; lateral lobes obliquely truncated, tufted with dense brushes of long yellow setæ; ventral surface of lobes with abundant smaller setæ, narrowly lacking on the midline behind base of the emargination.

Habitat.—China (Szechwan-Tibet border).

Holotype, male, Mupin, altitude 3,500 feet, June, 1929 (*Graham*); type in the United States National Museum collection.

The present species is most nearly allied to *Ctenacroscelis libertus* Alexander, differing in the coloration of the mesonotum and wings, and in the structure of the male hypopygium, especially of the styli and the eighth sternite.

TIPULA (SINOTIPULA) HUTCHINSONÆ sp. nov. Plate 1, fig. 5; Plate 2, figs. 29, 30.

Allied to *griseipennis;* frontal prolongation of head elongate, nasus lacking; antennal flagellum almost uniformly brownish black; head gray, with a median brown area; mesonotal præscutum gray, with three darker gray stripes that are narrowly bordered by dark brown; legs yellow, the tips of femora, tibiæ, and basitarsi narrowly darkened; wings whitish subhyaline, with a pale gray and grayish brown tesselated pattern; abdomen (male) chiefly yellow, the basal tergite gray, the terminal two segments black; in female, abdominal tergites broadly darkened laterally; male hypopygium with the median tergal lobe very low and obtuse, set with microscopic black spines and

spinous setæ; a single complex bilobed dististyle; eighth sternite unarmed.

Male.—Length, about 18 millimeters; wing, 20.5.

Female.—Length, about 23 to 24 millimeters; wing, 27.

Frontal prolongation of head long and slender, entirely without nasus, brownish black; palpi black, relatively short. Antennæ with scape and pedicel yellow; flagellum almost uniformly brownish black, the basal enlargements of the segments only a trifle darker than the remainder; flagellar segments very feebly incised; verticils shorter than the segments. Head gray, the central portion of the postfrons and vertex occupied by a conspicuous dark brown area; vertical tubercle low and indistinct.

Mesonotal præscutum light gray, with three darker gray stripes, the broad median stripe narrowly bordered on outer margins by dark brown and further split by a very indistinct, paler gray, median vitta; lateral stripes with a dark brown spot at cephalic-lateral portion; female with lateral stripes entirely bordered by dark brown; scutal lobes gray, each variegated by two brown areas, the more anterior smaller and darker; scutellum and mediotergite gray, the latter with indications of a darker median vitta. Pleura dark gray, the dorsopleural membrane infuscated; a few short setæ on propleura. Halteres obscure yellow, the bases of knobs infuscated. Legs with the coxæ gray; trochanters pale, their apices darkened; femora yellow, the tips narrowly but conspicuously blackened; tibiæ and basitarsi obscure yellow, clearer basally, the tips narrowly brownish black; remainder of tarsi brownish black. Wings (Plate 1, fig. 5) whitish subhyaline, with a pale gray and grayish brown tesselated pattern, distributed about as in other members of the subgenus; stigma and a confluent area on anterior cord, together with a small spot at origin of Rs, darker; cells C and Sc uniformly pale; small spots of the ground color in outer ends of cells R_2 to 2d A, inclusive, becoming larger in the posterior cells; veins brownish yellow to pale brown. Venation: R_{1+2} entire; Rs from one-third to one-half longer than m-cu.

Abdomen (male) obscure yellow, the basal segment gray, the succeeding segments more grayish laterally; sternites narrowly darkened on sides; outer two segments uniformly brownish black. In female, abdomen with basal tergite gray, succeeding segments chiefly dark brown, bordered laterally and caudally by grayish, the median region of tergites broadly yellow. Male

hypopygium (Plate 2, fig. 29) with the suture between the tergite, 9*t*, and sternite, 9*s*, feebly indicated; ninth sternite deeply emarginate, the edges of the incision with abundant short erect brown setæ. Ninth tergite (Plate 2, fig. 30, 9*t*) short and compact, the median area decurved into a low obtuse lobe set with short dense black spines and spinous setæ. A single complex dististyle, about as illustrated (Plate 2, fig. 30, *d*). Eighth sternite unarmed.

Habitat.—Kashmir.

Holotype, male, Baltistan, altitude 14,000 feet, July 18, 1934, resting under rocks on stony hillside (*Hutchinson*).

Allotopotype, female. Paratype, female, Deosai, Shingo Valley, altitude 11,800 feet, July 24, 1934 (*Hutchinson*).

I take great pleasure in naming this striking fly in honor of the collector, Miss Vivien R. Hutchinson, who has added materially to our hitherto scanty knowledge of the Tipulidæ of Kashmir. The fly is most nearly related to *Tipula* (*Sinotipula*) *griseipennis* Brunetti, which differs evidently in the bicolorous antennæ and in the structure of the male hypopygium, as the apex of the tergal lobe.[3]

TIPULA (ACUTIPULA) IRREQUIETA sp. nov. Plate 1, fig. 6; Plate 2, fig. 31.

General coloration gray, præscutal stripes not or scarcely indicated; antennæ yellow; wings with cells of outer radial field whitish, the remaining cells pale yellowish brown to gray; abdominal tergites brownish gray, the sublateral borders darker brown; male hypopygium with the tergite and sternite separated by a weak suture; median lobe of tergite very low and depressed, with a small notch, producing two broad obtuse lobules set with blackened spines.

Male.—Length, about 19 millimeters; wing, 18.

Frontal prolongation of head light brown; nasus distinct; palpi chiefly pale. Antennæ yellow, the bases of the flagellar segments not or scarcely darkened; verticils considerably longer than the segments. Head brown, the front and anterior vertex more silvery gray.

Pronotum yellowish gray. Mesonotum gray, the præscutal stripes not or scarcely indicated; humeral region restrictedly pale yellow; lateral portions of mediotergite narrowly pale. Pleura yellowish gray, the dorsal pleurotergite somewhat darker. Halteres dusky, the base of stem scarcely paler. Legs with the

[3] Edwards, Rec. Indian Mus. 26 (1924) 305; Ann. & Mag. Nat. Hist. X 1 (1928) 687.

coxæ and trochanters yellow; femora and tibiæ yellowish brown, the tips narrowly and weakly darkened; tarsi pale brown, passing into darker. Wings (Plate 1, fig. 6) narrow, conspicuously bicolorous; ground color of cells before cord and outer medial field pale yellowish brown to gray, the outer radial field and cell 1st M_2 abruptly whitish, this latter color likewise involving restricted portions of cells R_1, R, and M, and narrow bases of M_1, 2d M_2, and M_3, cells C and Sc infumed but much paler than the brown stigma; a conspicuous dark cloud in outer end of cell M; veins brown. Macrotrichia of veins beyond cord virtually lacking. Venation: R_{1+2} elongate, nearly straight, subequal to Rs or R_{4+5}; petiole of cell M_1 shorter than r-m.

Abdominal tergites brownish gray, the sublateral borders rather broadly darker brown, the extreme lateral margins gray; sternites a little paler, bordered with dusky. Male hypopygium with the tergite and sternite separated by a weak suture; basistyle separated by a ventral suture only. Ninth tergite (Plate 2, fig. 31, 9*t*) with the median lobe very low and depressed, with a small notch that produces two broad obtuse lobules that are set with blackened spines. Outer dististyle, *od*, very broad, pale. Inner dististyle, *id*, complex, as figured.

Habitat.—Kashmir.

Holotype, male, Skarda, Baltistan, altitude 7,000 feet, September 10, 1934, at light in tent (*Hutchinson*).

Tipula (*Acutipula*) *irrequieta* is very different from all other described species of the subgenus, differing especially in the peculiar nature of the wing pattern and in the structure of the male hypopygium. The suture between the tergite and the sternite of the latter is more distinct than in most other species of the subgenus. The present fly shows several points of resemblance to the typical subgenus *Tipula*, especially to members of the *oleracea* group, but from the structure of the hypopygium and the nature of the trichiation of the wing veins I prefer to place it in *Acutipula*, at least until more material becomes available.

TIPULA (OREOMYZA) BALTISTANICA sp. nov. Plate 1, fig. 7; Plate 2, figs. 32, 33.

Belongs to the *variipennis* group; nasus distinct; general coloration gray, the præscutum with four entire brown stripes; femora yellow, the tips narrowly but conspicuously blackened; claws (male) simple; wings cream-colored, variegated by abundant zigzag pale gray clouds; basal section of R_{4+5} reduced, abdominal tergites orange-yellow, with a broad, brownish black,

lateral stripe; eighth and ninth sternites blackened; male hypopygium with the eighth sternite transverse or weakly convex across margin, set with abundant spinous setæ.

Male.—Length, 11 to 12 millimeters; wing, 12 to 13.5.

Frontal prolongation of head gray, relatively long; nasus distinct, tufted with long yellow setæ; palpi black. Antennæ (male) moderately long, if bent backward extending about to root of halteres; scape and pedicel brownish yellow, flagellum black; flagellar segments moderately incised, with verticils that are shorter than the segments. Head gray, the orbits a trifler clearer gray.

Mesonotal præscutum light gray, with four entire brown stripes, the anterior ends of the intermediate pair obsolescent; pseudosutural foveæ black, subcircular; scutal lobes gray, each with two separate brown areas; scutellum and mediotergite gray, the parascutella more yellow. Pleura gray; dorsopleural membrane yellow. Halteres obscure yellow, the knobs infuscated. Legs with the coxæ gray; trochanters brownish yellow; femora yellow, the tips narrowly but conspicuously blackened, the amount subequal on all legs; tibiæ brownish yellow, becoming more obscure outwardly, the tips blackened; tarsi brownish black; claws (male) simple. Wings (Plate 1, fig. 7) with the ground cream-colored, variegated by tesselated pale gray clouds; cell Sc and the stigma uniformly brown; the zigzag cream and gray areas include all cells; the posterior prearcular region and bases of anal cells pale; veins dark. Venation: Basal section of R_{4+5} reduced; veins inclosing cells M_1 and 1st M_2 arcuated, as in the group.

Abdominal tergites orange-yellow, with a broad, brownish black, lateral stripe that is narrowly interrupted at the posterior portion of the segments; sternites similar, the eighth and ninth sternites blackened. Male hypopygium (Plate 2, fig. 32) small; tergite, 9*t*, and sternite separate; ventral suture short. Ninth tergite (Plate 2, fig. 32, 9*t*) with a broad rounded emargination on posterior border, the lateral lobes decurved into blackened points that are more or less bifid at tips. Basistyle, *b*, at proximal ends of dististyles with an obtuse blackened lobe on mesal aspect. Both dististyles (Plate 2, fig. 33, *id*, *od*) small and simple, dark-colored; outer style flattened, the margin at base narrowly blackened and microscopically roughened. Eighth sternite, 8*s*, with apex transverse or weakly convex, set with abundant spinous setæ.

Habitat.—Kashmir.

Holotype, male, Baltistan, altitude 11,800 feet, July 2, 1934 (*Hutchinson*). Paratopotypes, 6 males, July 2 to 4, 1934; paratype, 1 male, Deosai, Shingo Valley, July 23, 1934 (*Hutchinson*).

The venation and the type of hypopygium of the present fly are much as in members of the *marmorata* group, but the claws of the male are simple and I am referring the species to the *variipennis* group. The fly bears a superficial resemblance to *Tipula* (*Oreomyza*) *tetragramma* Edwards (Yunnan), but is amply distinct.

TIPULA (OREOMYZA) VENERABILIS sp. nov. Plate 1, fig. 8; Plate 3, fig. 34.

General coloration brownish gray, the præscutum with four narrow brown stripes; antennæ (male) relatively long, if bent backward extending about to base of abdomen; legs black, the femoral bases brightened; claws simple; wings narrow, obscure yellow, the prearcular field orange-yellow; a sparse clouded brown pattern, including an area in center of outer radial field; m-cu close to fork of M; abdomen brownish yellow, the lateral portions of the tergites darkened; male hypopygium with the ninth tergite notched, the margins set with blackened spines; eighth sternite with caudal margin convexly rounded, without lobes.

Male.—Length, 10 to 13 millimeters; wing, 11 to 14.

Frontal prolongation of head brownish black, gray pruinose; nasus long and slender; palpi black. Antennæ with scape and pedicel yellow; flagellum black; antennæ moderately elongate, in male, if bent backward extending about to base of abdomen; flagellar segments feebly incised; verticils shorter than the segments; terminal segment globular. Head brownish gray, somewhat darker behind.

Mesonotal præscutum brownish gray, clearer gray on lateral and humeral portions; four narrow dark brown stripes, the anterior ends of the intermediate pair invaded by gray; pseudosutural foveæ reduced to tiny black spots; scutum gray, each lobe with two brown areas; posterior sclerites of notum gray. Mesonotum small and relatively low. Pleura gray; dorsopleural region brownish yellow. Halteres brown, the knobs darker. Legs with the coxæ gray; trochanters brownish yellow; femora black, the bases restrictedly obscure yellow; tibiæ and tarsi black; claws simple. Wings (Plate 1, fig. 8) narrow; ground color obscure yellow, the prearcular field orange-yellow; stigma brown;

a conspicuous brown cloud in outer radial field, involving cells R_2 and R_3 but not reaching apices of cells, more extensive in some specimens than in others but apparent in all individuals; cell C pale brownish yellow, Sc clearer yellow; a pale brown cloud on anterior cord; weak gray washes in outer ends of cells Cu, 1st A, and 2d A; veins brown, the prearcular veins and basal third of M yellow. Venation: Sc_1 indicated by a spur; R_{1+2} preserved; Rs elongate, with strong trichia; cell 1st M_2 narrow, parallel-sided; petiole of cell M_1 subequal to or exceeding m; M_{3+4} very short to virtually lacking; m-cu on M_4 just beyond origin and thus close to fork of M.

Abdomen brownish yellow, the lateral portions of the tergites narrowly gray, the sublateral portions of both tergites and sternites weakly infuscated, becoming somewhat more extensive on outer segments; basal tergite gray; subterminal sternites brownish gray; hypopygium pale. The paratype from Deosai has the abdomen uniformly dark gray, the caudal and lateral borders of the segments narrowly yellow. Male hypopygium (Plate 3, fig. 34) small and simple; suture between tergite, 9*t*, and sternite indicated; suture between basistyle, *b*, and sternite long and straight. Ninth tergite, 9*t*, extensive, broader than long, the caudal margin with a very broad V-shaped emargination, at base of which is a small U-shaped notch; apical margin of lobes set with small blackened spines; a group of from fifteen to twenty black setæ surrounding the median notch; on ventral surface near lateral border with a small curved appendage on either side. Basistyle, *b*, with a blackened obtuse lobe on mesal aspect at base of dististyles. Both dististyles, *id*, *od*, simple, the outer with posterior margin on basal half narrowly blackened. Eighth sternite, 8*s*, with apex convexly rounded, with a few strong, erect, black setæ at this point.

Habitat.—Kashmir.

Holotype, male, Upper Pulwar Nullah, altitude 11,000 feet, October 2, 1934 (*Hutchinson*). Paratopotypes, 20 males; paratype, male, Deosai, altitude 13,000 feet, September 13, 1934 (*Hutchinson*).

I refer the species to *Oreomyza* with some slight doubt. The general appearance is more as in some members of the typical subgenus, as the *luteipennis* group, but the present insect seems to be more nearly related to *variipennis* and allies. The peculiar wing pattern is distinctive.

TIPULA (OREOMYZA) ICARUS sp. nov. Plate 1, fig. 9; Plate 3, figs. 35, 36.

Sexes strongly dimorphic, the males fully winged, the females subapterous; mesonotal præscutum light gray with two intermediate more brownish stripes that are a little bowed at midlength; fore femora chiefly blackened, the remaining femora reddish brown with the tips narrowly blackened; wings (male) almost uniformly grayish yellow, the stigma pale yellowish brown; abdominal tergites dark gray, narrowly margined caudally and laterally with yellow; male hypopygium with lateral lobes of tergite of unusual length.

Male.—Length, 10 to 12 millimeters; wing, 12 to 15.

Female.—Length, about 13 to 14 millimeters; wing, 2.8 to 3.

Male.—Frontal prolongation of head of moderate length, dark gray; nasus short and stubby, with long yellow setæ. Antennæ of moderate length; scape and pedicel brownish black, flagellum black throughout; flagellar segments not or scarcely incised; verticils subequal to or shorter than the segments. Head gray; anterior vertex broad.

Mesonotal præscutum light gray, with two, intermediate, more brownish stripes that are a little bowed at midlength, inclosing a slightly darker gray median vitta; lateral stripes obsolete; scutal lobes weakly darkened; posterior sclerites of notum gray. Pleura gray; dorsopleural membrane buffy. Halteres brown, the base of stem yellow, the knob dark brown. Legs with the coxæ gray; trochanters obscure yellow; fore femora chiefly blackened, the bases narrowly pale; middle and posterior femora more reddish brown, the tips narrowly blackened; tibiæ brown, the tips narrowly darkened; tarsi black; tibial spur formula 1–2–2; claws simple. Wings (Plate 1, fig. 9) broad, almost uniformly grayish yellow; stigma pale yellowish brown; veins brown. Macrotrichia abundant on veins beyond cord but lacking on Rs; squama naked. Venation: R_{1+2} elongate, with trichia on basal two-thirds; petiole of cell M_1 exceeding m; M_{3+4} subequal to basal section of M_{1+2}; m-cu just beyond origin of M_4.

Basal tergite chiefly buffy; succeeding tergites dark gray, narrowly margined laterally and caudally with yellow; hypopygium pale reddish; sternites almost uniformly gray. Male hypopygium (Plate 3, fig. 35) with the tergite, 9*t*, separated from the sternite, 9*s*; basistyle, *b*, and sternite chiefly fused, but with the suture indicated though delicate. Ninth tergite (Plate 3, fig. 36, 9*t*) with lateral lobes of unusual length, the median

region of the notch produced into a low obtuse mound; lobes with the setæ sparse, erect or even retrorse at near midlength. Basistyle with outer end gradually narrowed to a subacute spinous point, on ventral surface with several elongate setæ. Outer dististyle (Plate 3, fig. 35, *od*) relatively slender, the distal two-thirds dilated into a weak blade, with abundant conspicuous setæ. Inner dististyle, *id*, with the outer margin at base prolonged into a flattened lobe. Membrane between eighth, 8*s*, and ninth sternites, 9*s*, with a median group of long yellow setæ, directed chiefly ventrad.

Female.—Generally as in male but subapterous. Mesonotal præscutum more buffy gray. Wings short and obtuse; venation distinct but distorted; costal margin with unusually abundant black trichia, darkening the border. Ovipositor with the cerci and hypovalvæ elongate, the tips of the latter more obtuse.

Habitat.—Kashmir.

Holotype, male, Baltistan, altitude 11,800 feet, August 2, 1934 (*Hutchinson*). Allotopotype, female, with the type. Paratopotypes, 5 males, 1 female, July 10 to August 2, 1934.

The present species is very different from other clear-winged species of the genus having nearly apterous females. The chief specific characters are to be found in the male hypopygium, notably of the tergite. The specific name, *icarus*, is in allusion to the flightless condition of the female.

TIPULA (LUNATIPULA) SUBMARMORATIPENNIS sp. nov. Plate 3, figs. 37, 38.

Belongs to the *marmoratipennis* group; general coloration of mesonotal præscutum light gray, with four darker gray stripes that are narrowly margined with light brown; antennæ bicolorous; pleura yellow, in cases with the dorsal sclerites darkened; femora, tibiæ, and basitarsi yellow, their tips narrowly blackened; wings yellow to brownish yellow, marmorate with brown and gray areas; abdomen fulvous, the tergites narrowly trivittate with black, without silvery areas; terminal segments in male darkened; male hypopygium with eighth sternite moderately sheathing, with lateral brushes of setæ, the median area with abundant small spinous points.

Male.—Length, 16 to 20 millimeters; wing, 21 to 26.

Female.—Length, 23 to 27 millimeters; wing, 25 to 30.

Frontal prolongation of head yellow above, darker laterally; nasus powerfully developed; palpi with basal three segments and proximal end of last dark brown, the remainder of terminal segment light yellow. Antennæ with scape and pedicel yellow;

flagellar segments bicolorous, the basal enlargements dark brown, the remainder brownish yellow, on outer segments more uniformly darkened; verticils exceeding the segments in length. Head buffy, overcast with light gray, the orbits brighter; a narrow dark brown vitta extends from the summit of the entire vertical tubercle almost to occiput.

Mesonotal præscutum light gray, with four darker gray stripes that are narrowly margined with light brown; setigerous punctures of interspaces relatively conspicuous; scutum light gray, the lobes variegated by darker gray; scutellum and mediotergite gray, with a very conspicuous, dark brown, median stripe. Pleura yellow, including the dorsopleural membrane, this latter darker in females; sternopleurite with pale setæ. Halteres buffy, the knobs dark brown with pale apices. Legs with the coxæ and trochanters pale yellow; femora yellow, the tips narrowly blackened; tibiæ and basitarsi pale yellow, the tips narrowly darkened, the outer tarsal segments black. Wings with the ground color yellow (female) to brownish yellow (male), variegated with brown and gray washes, arranged about as in the *marmoratipennis* group; conspicuous brown clouds at ends of longitudinal veins; an oblique pale yellow line at near midlength of cell M, separating two pale brown washes; veins brown, more yellow in the female. Venation: Cell 1st M_2 strongly pointed at inner end; petiole of cell M_1 short; m-cu strongly arcuated, placed before midlength of cell 1st M_2.

Abdominal tergites fulvous, narrowly trivittate with brownish black, the terminal segments (male) brownish black, sparsely pruinose; in female, abdomen more uniformly brightened, the dark vittæ very narrow, the terminal segments weakly darkened; no silvery patches on abdomen, as is the case in allied species. Male hypopygium (Plate 3, fig. 37) with the tergite, 9*t*, separated from the sternite, 9*s*, by an incomplete suture. Ninth tergite (Plate 3, fig. 38, 9*t*), viewed from above, with a pair of low sublateral tubercles that are tipped with a brush of long coarse black setæ; and a pair of submedian tubercles similarly clothed with short spinous setæ; viewed from the side, a blackened point protrudes caudad. Outer dististyle (Plate 3, fig. 38, *od*) boomerang-shaped, at apex with three or four black spines. Inner dististyle (Plate 3, fig. 38, *id*) arcuate, the distal half narrowed into a slender blackened point, the outer margin with long coarse setæ. Eighth sternite (Plate 3, fig. 37, 8*s*) only slightly sheathing; apex subtruncate, each outer angle with a

brush of scanty long yellow setæ; the broad median area is abundantly dotted with tiny, blackened, peglike spines. Ovipositor with short, fleshy, divergent valves, as in the group.

Habitat.—Kashmir.

Holotype, male, Upper Pulwar Nullah, altitude 11,000 feet, October 2, 1934 (*Hutchinson*). Allotype, female, Lower Pulwar Nullah, altitude 9,000 feet, October 12, 1934, came to light in tent; camp in walnut grove near spring (*Hutchinson*). Paratopotype, 1 female, with type; paratypes, 1 male, 1 female, with the allotype.

The nearest regional ally is *Tipula* (*Lunatipula*) *marmoratipennis* Brunetti (Darjiling, eastern Himalayas, altitude 7,000 feet, May and August). I have been privileged to study both the holotype and paratype specimens of this latter species and have provided supplementary details of structure and coloration in another paper. The latter fly has the antennal flagellum almost uniform obscure yellow, scarcely bicolorous; tibiæ and tarsi brownish black; basal five abdominal tergites orange-fulvous (female), trivittate with black, the segments with silvery gray lateral areas; outer abdominal segments darker brown, heavily pruinose.

TIPULA (LUNATIPULA HYPOVALVATA sp. nov. Plate 1, fig. 10; Plate 3, figs. 39, 40.

General coloration of præscutum yellowish gray, with two narrow brown intermediate stripes; pleura yellow; antennæ bicolorous; wings strongly tinged with brownish yellow, obliterative areas restricted; basal segments of abdomen yellow, in female with conspicuous brown lateral stripes; subterminal segments of abdomen darkened; male hypopygium with caudal margin of tergite trilobed; basistyle produced into an obtuse flattened lobe; a long setiferous lobe in membrane between eighth and ninth tergites; female with hypovalvæ reduced to slender dark spines.

Male.—Length, 13 to 13.5 millimeters; wing, 12.5 to 13.5.

Female.—Length, about 19 millimeters; wing, 15.

Frontal prolongation of head yellow, scarcely darker laterally; nasus distinct; palpi brown, the relatively short terminal segment darker brown. Antennæ (male) moderately elongate, if bent backward extending nearly to root of halteres; basal three segments yellow, the succeeding segments bicolorous, the basal enlargements dark, the terminal segments more uniformly darkened. Head brownish gray, the front and posterior orbits somewhat clearer gray.

Mesonotal præscutum yellowish gray, with two narrow brown intermediate stripes, their anterior ends subobsolete and passing into gray; scutum yellowish gray, the scutellum and mediotergite clearer yellow. Pleura yellow, including the dorsopleural membrane. Halteres infumed. Legs with the coxæ and trochanters light yellow; femora yellow, the tips very narrowly and indistinctly darkened; tibiæ brownish yellow, the tips very narrowly infuscated; tarsi passing through obscure yellow to black. Wings (Plate 1, fig. 10) with a strong and almost uniform brownish yellow tinge, cell Sc clearer yellow, cell C more brownish yellow; stigma pale brown; obliterative areas before the stigma and along cord very restricted, beyond the stigma scarcely evident; veins pale brown. Squamal setæ from five to seven in number, strong; trichia of veins beyond cord relatively short but numerous. Venation: R_{1+2} entire; cell 1st M_2 elongate, its outer end somewhat pointed by the obliquity of m, the latter longer than the petiole of cell M_1.

Abdomen (male) yellow, the seventh to ninth tergites blackened; sternite seven blackened basally and at sides, the caudal portion pale; ninth sternite paler; a very indistinctly darker lateral stripe on tergites. What evidently represents the female of this same species has the abdomen quite different in pattern, the tergites with a very broad and conspicuous brownish black lateral stripe; tergites seven to nine more uniformly blackened; tergal shield more polished chestnut-brown; cerci relatively strong, nearly straight, the valves lying obliquely or subtransversely; hypovalvæ reduced to slender dark spines, their tips more or less convergent. Male hypopygium (Plate 3, fig. 39) with the tergite, 9*t*, entirely separated from the sternite, 9*s*, by a suture. Ninth tergite (Plate 3, fig. 40, 9*t*) with the caudal margin trilobed, the lateral lobes longer but slender; a smaller, more-depressed, median lobe at end of a U-shaped dorsal depression. Basistyle, *b*, with the ventral suture well indicated, the apical portion of the sclerite produced into an obtuse flattened lobe. Outer dististyle (Plate 3, fig. 40, *od*) slender, with abundant setæ on distal half. Inner dististyle, *id*, with a complex setiferous lobe at base of outer portion. A fleshy cushion on membrane between the eighth, 8*s*, and ninth, 9*s*, sternites, provided with long conspicuous yellow setæ.

Habitat.—Kashmir.

Holotype, male, Sind Valley, altitude 9,000 feet, June 14, 1934 (*Hutchinson*). Allotopotype, female. Paratopotype, male;

paratypes, 3 males, without exact locality, altitude 9,000 feet, August 21, 1934 (*Hutchinson*).

The present species is most closely allied to *Tipula* (*Lunatipula*) *manca* Alexander and *T.* (*L.*) *terebrina* Alexander, differing especially in the venation, coloration of the wings, and details of structure of the male hypopygium. The structure of the ovipositor is very peculiar.

TIPULA XANTHOCERA sp. nov. Plate 1, fig. 11; Plate 3, figs. 41, 42.

Allied to *ligulifera;* mesonotal præscutum brown, with four grayish brown stripes; antennæ (male) elongate, approximately one-half as long as body, the basal segments yellow, the outer segments bicolorous, the basal enlargement of each segment yellow, the apical portion darker; femora and tibiæ yellow, the tips narrowly blackened; wings broad, strongly suffused with yellow; cell M_1 short-petiolate; abdomen yellow, the tergites trivittate with black, the lateral stripes very broad and conspicuous; a subterminal black ring; male hypopygium with a tooth on mesal face of outer dististyle; a conspicuous flattened lobe at extreme base of ninth sternite.

Male.—Length, about 12 millimeters; wing, 10.5; antenna, about 6.

Frontal prolongation of head relatively short, entirely yellow; nasus distinct; palpi brownish yellow. Antennæ (male) elongate; basal half yellow, the outer segments bicolorous, with the basal enlargements of the individual segments light yellow, the long apical pedicels pale brown; flagellar segments feebly incised; verticils shorter than the segments. Head yellowish brown, with a faint gray cast.

Mesonotal præscutum brown, with four grayish brown stripes that are poorly defined against the ground; scutal lobes grayish brown, the median region and posterior portions of the lobes a trifle brightened; scutellum yellowish gray; mediotergite brownish yellow. Pleura uniformly pale yellow. Halteres yellow, the base of knob weakly darkened. Legs with the coxæ and trochanters pale yellow; femora and tibiæ yellow, the tips narrowly but conspicuously blackened; basitarsi brown, passing into black; remainder of tarsi black; claws simple. Wings (Plate 1, fig. 11) broad, uniformly suffused with yellow, the prearcular and costal fields more saturated yellow; stigma small, pale brown; veins yellow. Venation: Rs short, subequal to m-cu; R_2 relatively long; R_{1+2} entire, very gently diverging from R_3; petiole

of cell M_1 very short; cell 1st M_2 parallel-sided or slightly narrowed at distal end; M_{3+4} very short; m-cu joining M_4 some distance beyond origin of latter.

Abdomen yellow, the tergites trivittate with brownish black, the median stripe very narrow and paler; lateral stripes broad and intense; all stripes beginning at base of tergite two, lateral stripes continuous, widening behind; segments seven and eight entirely black, the hypopygium chiefly paler; sternites pale yellow, the subterminal segments weakly darkened. Male hypopygium (Plate 3, fig. 41) small, the tergite, 9*t*, entirely separated from the elongate sternite-basistyle, 9*s*, by membrane; median notch of sternite with a tumid U-shaped setiferous lobe on posterior half. Ninth tergite (Plate 3, fig. 42, 9*t*) extensive, flattened, the caudal margin with a broad V-shaped notch, with a small, pale, triangular point at base; mesal margins of lobes set with blackened peglike spines; ventral surface of tergite with extensive and conspicuous lobes and projections. Outer dististyle (Plate 3, fig. 42, *od*) narrow, on inner face at near midlength with a very conspicuous erect black spine. Inner dististyle as shown (Plate 3, fig. 42, *id*); posterior margin near base with a small setiferous lobe. At extreme cephalic end of ninth sternite a conspicuous flattened pale ligula (Plate 3, fig. 41, 9*s*), slightly obovate in outline, the apex truncated to very weakly emarginate medially; surface with abundant delicate setæ.

Habitat.—Kashmir.

Holotype, male, Gurais, altitude 7,000 feet, September 15, 1934 (*Hutchinson*).

The nearest ally of the present fly is *Tipula ligulifera* Alexander (eastern Siberia), which differs in the narrower wings, short antennæ, and details of coloration and structure of the male hypopygium. I am still unable to place these species in a subgeneric group, but am inclined to believe that they may best be placed in *Yamatotipula*. The resemblance to species of the *luteipennis* group of the typical subgenus is superficial only.

NEPHROTOMA INCONSEQUENS sp. nov. Plate 1, fig. 12; Plate 4, fig. 43.

Size small; flagellar segments (male) strongly binodose; pronotum orange; præscutum orange, with three highly polished black stripes; mediotergite and pleura orange; femora yellow, the tips very narrowly dark brown; wings subhyaline, stigma pale, ill-delimited; no stigmal trichia; abdomen orange, the sev-

enth tergite and eighth sternite variegated by dark brown; male hypopygium with the inner dististyle without dorsal crest; eighth sternite gently emarginate medially, the broad lobes with sparse strong setæ; gonapophyses about twice as long as wide, the tips obtuse.

Male.—Length, about 9 millimeters; wing, 8.5.

Frontal prolongation of head light brown, including nasus; palpi dark brown, the terminal segment brownish black. Antennæ with the basal three segments yellowish brown, the remainder black; flagellar segments very strongly incised, the outer swelling longer and almost as high as the basal enlargement; verticils shorter than the segments, those on ventral face of enlargement very short. Head deep fulvous-brown; occipital brand small, poorly differentiated from the ground; vertex with a reticulate pattern of delicate blackish lines; vertical tubercle entire.

Pronotum deep orange. Mesonotal præscutum deep orange, with three highly polished black stripes that are not bordered by a different color; lateral stripes straight but with a paler brown suffusion laterad of their anterior ends; scutum obscure yellow, each lobe with two confluent polished black areas; scutellum brown, the parascutella a little more orange; mediotergite dull orange, the posterior border with paired darker spots. Pleura dull orange-yellow, vaguely darker on ventral sternopleurite. Halteres dusky. Legs with the coxæ obscure yellow, with long conspicuous yellow setæ; trochanters yellow; femora yellow, the tips very narrowly and indistinctly darker brown; tibiæ brownish yellow, the tips narrowly darkened; tarsi black. Wings (Plate 1, fig. 12) subhyaline; cell Sc a little darker; stigma pale, ill-delimited, the caudal edge a trifle darker; veins brown. Stigma without trichia. Venation: Sc_2 ending opposite origin of Rs, Sc_1 represented by a spur; cell M_1 narrowly sessile; cell 1st M_2 gently widened outwardly; m-cu at fork of M_4, the latter a little basad of M_3.

Abdomen orange; tergites unmarked medially except for the seventh segment, which is blackened except laterally at base; a narrow but conspicuous brownish black stripe on lateral margins of tergites from segments two to four, inclusive; sternites yellow, unmarked, except for the basal third of the eighth sternite, which is dark brown; hypopygium orange-yellow. Male hypopygium with the ninth tergite (Plate 4, fig. 43, 9*t*) having strong sclerotized lateral horns, divergent, each with about three

black peglike spines on basal half of mesal face; lobes of tergite truncated, separated by a small U-shaped notch, their surface with abundant black spines and spinous setæ. Outer dististyle, *od*, of moderate size, the apical point short. Inner dististyle, *id*, without dorsal crest; apical beak long and slender; posterior margin of style with two powerful setæ, additional to the abundant pale normal setæ. Eighth sternite, 8*s*, with the caudal margin gently notched medially, the broad obtuse lobes with stronger and more abundant setæ, directed caudad and mesad. Gonapophyses, *g*, appearing as small flattened blades, oval in outline, about twice as long as wide and much shorter than the ædeagus, the tips obtuse.

Habitat.—Central Celebes (Bontoe Batoe District).

Holotype, male, Latimodjong Mountains, altitude 4,500 to 6,000 feet, May 25, 1931 (*Clagg*).

Among the more than one hundred described species of *Nephrotoma* in eastern Asia and the Malayan Islands, the present fly is best distinguished by the combination of small size, strongly binodose flagellar segments in the male, highly polished præscutal stripes, virtually immaculate mediotergite and pleura, lack of stigmal trichia, and the almost unmarked abdomen. The details of structure furnish additional characters to separate the fly from other regional small-sized members of the genus.

NEPHROTOMA PARASCUTELLATA sp. nov. Plate 1, fig. 13; Plate 4, fig. 44.

General coloration yellow; mesonotal præscutum with three black stripes, the lateral pair outcurved at anterior ends; scutellum yellow, parascutella black; mediotergite yellow, the posterior third blackened; orbital darkening appearing as elongate dashes; halteres black; legs black, the femoral bases narrowly yellow; wings subhyaline, the stigma and cells Sc and Cu_1 brownish black; intermediate abdominal segments yellow, with black posterior triangles, the outer segments and hypopygium black; eighth sternite of male hypopygium weakly emarginate.

Male.—Length, about 12 to 13 millimeters; wing, 10 to 10.5.

Female.—Length, about 15 millimeters; wing, 11.5 to 12.

Frontal prolongation of head obscure yellow, darker ventrally beneath and on sides; nasus and an adjoining area brownish black; palpi black. Antennæ with scape yellow; pedicel dark brown; flagellum black; antennæ (male) of moderate length, if bent backward extending about to root of halteres; flagellar segments moderately incised, with verticils that are shorter than

the segments. Head orange-yellow, clearer yellow in front; occipital brand small and only feebly differentiated from the ground; orbital darkenings appearing as elongate dashes extending from the narrowest point of the vertex caudad, gradually diverging from the eye margin.

Pronotum light yellow, the sides extensively blackened. Mesonotal præscutum yellow, more orange-yellow on interspaces; three black stripes, the surface feebly nitidous, the lateral stripes outcurved to margin; scutum broadly yellow medially, the lobes extensively black, the color extended laterad and including the outer ends of suture, restricting the lateral yellow areas of the præscutum to small spots before the suture; scutellum light yellow, the parascutella conspicuously black, contrasting markedly with the scutellum; mediotergite clear light yellow, with about the posterior third brownish black. Pleura yellow, the anepisternum and ventral sternopleurite more reddish; pleurotergite black on dorsal and ventral portions, isolating a central pale yellow area. Halteres black, the knobs not or scarcely brightened. Legs with the coxæ and trochanters yellow; femora black, the bases somewhat narrowly yellow, more extensive on the fore and middle legs where about the basal fourth or fifth is brightened, much narrower on posterior femora; tibiæ brownish black; tarsi black. Wings (Plate 1, fig. 13) subhyaline; cell Sc and the stigma brownish black; cell Cu_1 (between the approximated branches of Cu) darkened; veins brownish black. Stigmal trichia variable in number, in males ranging to 15 or 18; in female almost lacking. Venation: Sc_2 ending approximately opposite the origin of Rs; cell M_1 short-petiolate to barely sessile.

Abdomen with basal tergite chiefly black; tergites two to five yellow, with black posterior triangles; outer segments, including hypopygium, black; shield of ovipositor black. Male hypopygium with the lateral horns of tergite (Plate 4, fig. 44, 9*t*) short and entirely pale, earlike, with three or four small spinous points on base; median notch small. Outer dististyle, *od*, small, the apex little-attenuated. Inner dististyle, *id*, with apical beak stout; dorsal crest lacking or indicated only by a weak protuberance; setæ of style short but black and conspicuous. Eighth sternite with median area gently emarginate, the broadly rounded lateral lobes with long pale yellow setæ.

Habitat.—West Java.

Holotype, male, Mount Malang, altitude 3,000 feet, August, 1933 (*Walsh*). Allotype, female, Buitenzorg, December, 1930

(*Handschin*), in the Natural History Museum, Basel, Switzerland. Paratopotypes, males, with the holotype.

The present fly bears a general resemblance to species such as *Nephrotoma doleschalli* (Osten Sacken) and *N. javana* (Wiedemann), but is unquestionably distinct from these and other regional species. The most characteristic features lie in the nature of the orbital darkenings, the black parascutella, the dark halteres and legs, and the pattern of the abdomen, with all outer segments, including hypopygium, blackened.

NEPHROTOMA MERACA sp. nov. Plate 1, fig. 14; Plate 4, fig. 45.

General coloration yellow, the præscutum with three polished black stripes, the lateral pair outcurved; antennæ bicolorous, with the bases of the flagellar segments reddish yellow, the remainder black; occipital brand large and conspicuous, more or less heart-shaped; a central dark longitudinal stripe on mediotergite; apices of knobs of halteres yellowish white; femora yellow, the tips narrowly but conspicuously blackened, the amount subequal on all legs; wings subhyaline, the stigma dark brown; wing tip and cord narrowly darkened; abdominal tergites yellow, with three broken black stripes; terminal segments darkened; male hypopygium with a long rectangular lobe from beneath the eighth sternite, its apex with a rounded notch.

Male.—Length, about 9 millimeters; wing, 9; antenna, about 5.

Frontal prolongation of head light yellow, the nasus and a small adjacent area blackened; palpi with basal segment obscure yellow; succeeding segments brown, terminal segment yellow. Antennæ moderately elongate; scape yellow, pedicel brown; basal flagellar segment black; flagellar segments beyond the first bicolored, the basal enlargement reddish yellow, the remainder black; outer segments more uniformly darkened; flagellar segments moderately incised; verticils shorter than the segments. Head yellow, the occipital brand large and conspicuous, more or less heart-shaped.

Pronotum yellow medially, broadly brownish black on sides. Mesonotal præscutum obscure yellow, with three polished black stripes that are not bordered by darker; lateral stripes outcurved, but the bent portion paler than the stripe itself; scutum yellow, each lobe with two black areas, the more anterior extended laterad along the suture; scutellum and parascutella obscure yellow; mediotergite yellow, with a faint median darkening, in type restricted to cephalic portion, in paratype continuous.

Pleura pale yellow, indistinctly variegated by more reddish areas on anepisternum and ventral sternopleurite. Halteres brownish yellow, the base of knob darkened, the apex broadly yellowish white. Legs with the coxæ orange, the base of fore coxa narrowly darkened; trochanters obscure yellow; femora yellow, the tips very indistinctly darkened; tarsi black. Wings (Plate 1, fig. 14) relatively broad, subhyaline; stigma oval, dark brown; a narrow brown seam on anterior cord; wing tip obtuse, narrowly margined with brown; a very narrow brown seam on vein M_4 to margin; other veins beyond cord less distinctly seamed; cell Sc entirely clear; veins brown. Only about four stigmal trichia. Venation: Sc relatively long, Sc_2 ending about opposite one-third the length of the relatively long Rs, Sc_1 indicated by a spur; cell M_1 sessile; m-cu at fork of M_4, the latter some distance before fork of M_3.

Abdomen yellow, the tergites with three broken black stripes, interrupted at basal portions of segments; caudal end of seventh tergite, eighth segment, and part of ninth segment black; remainder of hypopygium light brown; sternites yellow, the seventh and eighth segments blackened. Male hypopygium with the ninth tergite (Plate 4, fig. 45, 9*t*) having caudal border with two broadly truncated lobes, the dorsal surface on either side elevated into blackened mounds, the median portion more reddish. Outer dististyle, *od*, yellow, the tip obtuse. Inner dististyle, *id*, with the beak very obtuse. From beneath the eighth sternite projects a small, long-rectangular, pale lobe, 8*s*, its apex with a small circular notch. Gonapophyses greatly reduced so as to be virtually lacking.

Habitat.—Kashmir.

Holotype, male, Baltistan, altitude 10,000 feet, June, 1934 (*Hutchinson*); came to light in tent in willow grove near glacier. Paratopotype, male.

The only other regional species having the coloration of the antennæ approximately as in the present fly is *Nephrotoma puncticornis* (Brunetti), of the eastern Himalayas, which is entirely different in the coloration of the head and body, having the præscutal stripes straight and the mediotergite bright light yellow, while the abdomen is chiefly yellow.

NEPHROTOMA TRILOBULATA sp. nov. Plate 1, fig. 15; Plate 4, fig. 46.

General coloration yellow, variegated with black; antennal flagellum black, the segments only weakly incised; a small dark spot before antennal bases; occipital brand large; lateral præ-

scutal stripes outcurved at anterior ends; wings yellowish subhyaline; stigma pale, only a little darker than the ground; cell Sc undarkened; stigmal trichia sparse; vein Sc_2 ending opposite origin of Rs; abdomen orange-yellow, the tergites interruptedly trivittate with black; hypopygium pale; male hypopygium with a depressed rectangular lobe from beneath the posterior margin of the eighth sternite, its apex trilobulate.

Male.—Length, 12.5 to 13 millimeters; wing, 11 to 12.

Female.—Length, about 15 to 16 millimeters; wing, 12.5 to 14

Frontal prolongation of head orange-yellow, the long nasus and a dorsal suffusion of the prolongation pale brown; palpi dark brown, the terminal segment somewhat paler. Antennæ with scape orange, remainder of organ black; flagellar segments only weakly incised; verticils shorter than the segments. A small bright brown triangular area on front before the antennal bases; posterior region of head orange, the orbits and genæ yellow; occipital brand large and conspicuous, shiny, narrowly bordered by opaque, in cases the anterior end sending a more or less entire prolongation to summit of tubercle; a very small and indistinct dark spot on anterior orbit opposite the narrowest point of vertex.

Pronotum yellow medially, conspicuously black on sides. Mesonotal præscutum yellow, with three polished black stripes, the lateral pair outcurved; median stripe crossing the suture behind; scutum yellow, the lobes conspicuously variegated with black, sending a narrow line across the suture and connecting with the lateral præscutal stripes; scutellum brown, parascutella yellow, narrowly blackened on mesal portion adjoining the scutellum; mediotergite pale yellow, with a median dark area that is narrower but darker on cephalic half of sclerite, on posterior half expanded and paling to light brown. Pleura sulphur yellow on anepisternum and sternopleurite, variegated with reddish brown areas; propleura and posterior sclerites of mesopleura more china white; a linear black area on suture between the anepisternum and sternopleurite. Halteres dark brown, the base of stem narrowly reddish, the apex of knob sulphur yellow. Legs with the coxæ yellow, the fore and middle coxæ more variegated with reddish; trochanters yellow; femora orange-yellow, the tips very narrowly and insensibly darkened; tibiæ light brown, passing into brownish black; tarsi black. Wings (Plate 1, fig. 15) yellowish subhyaline; stigma pale, only a little darker than the ground; cell Sc scarcely darker than cell C; veins brown. Stig-

mal trichia about six in number. Venation: Sc_2 ending opposite origin of Rs, Sc_1 preserved; cell M_1 narrowly sessile to short-petiolate; m-cu just before fork of M_4.

Abdomen orange-yellow, the tergites narrowly trivittate with black, the stripes interrupted at posterior border of each segment; outer segments almost uniformly pale, the outer end of the seventh tergite and basal portion of the eighth infuscated; hypopygium pale. Male hypopygium with the tergite (Plate 4, fig. 46, 9*t*) bearing two divergent lobes, separated by a V-shaped notch, the margins of the lobes provided with a series of blackened points and spinous setæ. Outer dististyle, *od*, moderately attenuated. Inner dististyle, *id*, with the apical beak slender; dorsal crest low. From beneath the caudal margin of the eighth sternite a rectangular depressed lobe, 8*s*, its apex trilobulate, the lateral lobules a little longer and more slender than the median one.

Habitat.—Kashmir.

Holotype, male, Baltistan, altitude 9,000 feet, June 20, 1934 (*Hutchinson*). Allotopotype, female, pinned with type. Paratopotype, 1 male; paratype, 1 female, altitude 10,000 feet, June 14, 1934.

Apparently most closely allied to *Nephrotoma consimilis* (Brunetti), which differs conspicuously in the small occipital brand, chiefly blackened femora, darkened terminal segments of abdomen, and structure of the hypopygium. It is evident that Brunetti had at least two species confused in the type series and original description of *consimilis*. I possess several paratype and metatype specimens received from Mr. Brunetti and am basing the above comparison upon paratypical material.

NEPHROTOMA IRREVOCATA sp. nov. Plate 1, fig. 16; Plate 4, fig. 47.

General coloration yellow, variegated by black; frontal prolongation of head with a narrow black median stripe; terminal segment of palpus yellow; antennal flagellum black; lateral præscutal stripes decurved; mediotergite with an inverted T-shaped brown area; knobs of halteres sulphur yellow; fore femora chiefly black, the remaining femora yellow, narrowly tipped with black; wings subhyaline, cell Sc and the stigma darkened; abdominal tergites orange-yellow, with three narrow black stripes, the seventh to ninth segments black; male hypopygium with the lateral horns of tergite small and acute, without spines; gonapophyses elongate.

Male.—Length, 11 to 12 millimeters; wing, 11 to 11.5.

Frontal prolongation of head yellow; nasus and a narrow but complete line on dorsum brownish black; palpi testaceous-yellow, the basal three segments in cases somewhat darker. Antennæ with scape and pedicel brownish yellow, flagellum black; flagellar segments moderately incised; verticils a little shorter than the segments. Front sulphur yellow, posterior portion of head more orange; occipital brand of moderate size, dark brown, sending an anterior prolongation part way up the high vertical tubercle; a more or less evident dark spot on anterior orbit at narrowest point of vertex.

Pronotum pale yellow, dark brown on sides. Mesonotal præscutum yellow, with three polished black stripes that are not or scarcely bordered by duller black; lateral stripes outcurved to margin, the decurved portion variable in intensity, in cases much paler than the stripes; scutum yellow, each lobe virtually covered by a large black area that follows the suture to the lateral border; scutellum pale brown, the parascutella yellow; mediotergite yellow, with an inverted T-shaped brown area, the crossbar sometimes paler than the stem. Pleura yellow, variegated by reddish on anepisternum, ventral sternopleurite, and meron; a brown or black dash on posterior portion of anepisternum. Halteres dusky, the base of stem narrowly reddish, the knobs chiefly bright sulphur yellow. Legs with the coxæ whitish, with more or less distinct reddish tinges; trochanters yellow; fore femora chiefly black, the basal third yellow; middle and hind femora yellow, the tips narrowly black, the amount involving about the distal eighth or less; tibiæ dark brown, the tips narrowly darker; tarsi black. Wings (Plate 1, fig. 16) subhyaline or with a very faint dusky tinge; cell Sc uniformly darkened; stigma dark brown; cell Cu_1 and wing tip less clearly darkened; veins dark brown. Stigmal trichia scanty, six to eight in number. Venation: Cell M_1 sessile; m-cu a short distance before fork of M_4.

Abdominal tergites orange-yellow, with three narrow black stripes, more or less interrupted at the incisures, in male with the seventh and succeeding segments intense black, only the outer dististyle pale yellow; impressed areas on basal rings of tergite distinct, confluent with the median dark stripe. Male hypopygium with the tergite (Plate 4, fig. 47, 9*t*) small, the caudal margin concave, with a submedian lobe on either side, the notch between long and narrow; margins of lobes set with microscopic blackened points and setæ; a smooth acute yellow blade on either

side of caudal portion; dorsal setæ restricted to posterior half of sclerite. Styli, *id, od,* as figured. Gonapophyses, *g,* long and slender, the distal half somewhat narrower than the base. Eighth sternite entire, with a small, pale, fleshy lobule protruding from beneath its margin.

Habitat.—Kashmir.

Holotype, male, Baltistan, altitude 10,000 feet, June, 1934 (*Hutchinson*). Paratopotypes, 2 males, with the type; 1 male, altitude 10,000 feet, June 22, 1934; 2 males, altitude 9,000 feet, June 19, 1934; 1 male, altitude 8,000 feet, June 19, 1934; came to light in tent at 8 p. m., at camp beside Dras River (*Hutchinson*).

By means of keys to the regional species of *Nephrotoma,* the present fly runs to *N. consimilis* (Brunetti) and *N. virgata* (Coquillett). The former differs conspicuously in the strongly tinted wings, with pale stigma and cell Sc, together with an entirely different male hypopygium. *Nephrotoma virgata* likewise has the stigma and cell Sc pale and with the hypopygium quite distinct in all details, more notably in the straplike appendage from behind the eighth sternite.

LIMONIINÆ

LIMONIINI

LIMONIA (LIMONIA) PROTRUSA sp. nov. Plate 1, fig. 17.

Rostrum yellow; antennæ relatively elongate; flagellum black; mesonotal præscutum with entire disk covered by a brownish black shield, the humeral region obscure yellow; legs dark brown; wings with a strong brown tinge; stigma long-oval, darker brown; Sc_1 ending about opposite two-thirds the length of Rs, Sc_2 at its tip; R_{1+2} jutting far beyond level of free tip of Sc_2 and R_2, which are both pale and lie in approximate transverse alignment; vein $Sc_2 + R_1$ bending strongly caudad as it enters the region of the stigma; m-cu at fork of M; abdominal tergites brownish black, the sternites somewhat paler with the bases of the segments narrowly darker.

Female.—Length, about 6 millimeters; wing, 6.8.

Rostrum yellow; palpi black. Antennæ with scape and pedicel obscure brownish yellow; flagellum black; antennæ relatively elongate (for female sex); flagellar segments cylindrical, with short apical pedicels; terminal segment about one-third longer than the penultimate. Head dark gray.

Pronotum reduced, yellow, becoming darker on sides. Mesonotal præscutum with the disk chiefly covered by a brownish

black shield, the humeral region obscure yellow; scutal lobes dark brown, the median area vaguely brightened; posterior sclerites of mesonotum dark brown. Pleura with dorsal half darker brown than the ventral yet not forming a dorsal stripe, the suffusion chiefly appearing on the ventral anepisternum. Halteres dusky, the base of stem restrictedly pale. Legs with the fore coxæ darker than the other coxæ; trochanters obscure yellow; remainder of legs dark brown, the femoral bases very restrictedly pale. Wings (Plate 1, fig. 17) with a strong brown tinge; stigma long-oval, darker brown; veins brown R_2 and the free tip of Sc_2 pale and without trichia. Venation: Sc long, Sc_1 ending about opposite two-thirds the length of Rs, Sc_2 close to its tip; R_{1+2} projecting beyond free tip of Sc_2 as a long spur that is provided with about a dozen trichia; free tip of Sc_2 and R_2 virtually in transverse alignment; vein $Sc_2 + R_1$ bending strongly caudad as it enters the region of the stigma; inner end of cell 1st M_2 slightly arcuated; m-cu at fork of M; anal veins convergent near origin, 2d A weakly sinuous.

Abdominal tergites brownish black, the sternites a trifle paler, with the bases of the intermediate segments rather narrowly darker; cerci very slender, the tips simple; hypovalvæ horn-yellow, the bases blackened.

Habitat.—China (Chekiang).

Holotype, female, hills back of Ning-po, halfway to Nimrod Sound, May 1, 1925 (*Suenson*).

The peculiar venation of the radial field, with vein R_{1+2} jutting far beyond the free tip of Sc_2, is a very uncommon condition in the typical subgenus, in the local fauna being found only in *Limonia* (*Limonia*) *monacantha* Alexander, which is entirely distinct in the conspicuously patterned wings.

LIMONIA (LIMONIA) LATICELLULA Alexander.

Limonia (*Limonia*) *laticellula* ALEXANDER, Philip. Journ. Sci. 49 (1932) 381–382.

Described from Szechwan, western China, altitude 6,000 to 11,000 feet, July, 1931 (*Franck*). Three males and females, near Bandapur, Kashmir, altitude 7,000 feet, November 4, 1934, flying beneath fir trees (*Hutchinson*).

LIMONIA (LIMONIA) HOSTILIS Alexander.

Limonia (*Limonia*) *hostilis* ALEXANDER, Philip. Journ. Sci. 51 (1933) 533–534.

Described from the Szechwan-Tibet border, at high altitudes, August 3 to 6, 1930 (*Graham*). Several males and females,

Mount Omei, Szechwan, altitude 10,800 to 11,000 feet, August 16 to 20, 1934 (*Graham*). One female, Bitzal Nullah, western Karakorams, Kashmir, altitude 14,000 feet, September 2, 1934 (*Hutchinson*).

LIMONIA (DICRANOMYIA) TRICUSPIDATA sp. nov. Plate 1, fig. 18; Plate 4, fig. 48.

Allied to *immodestoides;* general coloration grayish brown; knobs of halteres darkened; femora and tibiæ pale brown, the tarsi brownish black; wings subhyaline, the short-oval stigma pale brown; Sc_1 longer than Rs; cell 1st M_2 open by atrophy of m; vein M_{3+4} longer than M_4; male hypopygium with the caudal margin of tergite deeply emarginate; ventral dististyle large and fleshy, its rostral prolongation with three subequal spines near base.

Male.—Length, about 6 millimeters; wing, 6.8 to 7.

Female.—Length, about 6 millimeters; wing, 7.

Rostrum brownish yellow to brown, the palpi only a little darker. Antennæ short, black throughout; flagellar segments short-oval, the outer segments somewhat longer; terminal segment approximately one-half longer than the penultimate. Head dark brownish gray.

Pronotum dark medially, paler on sides. Mesonotal præscutum dark grayish brown medially, the humeral region brighter; scutal lobes darkened, the median region paler; posterior sclerites of notum grayish brown. Pleura chiefly darkened, pruinose. Halteres pale, the knobs infuscated. Legs with the coxæ and trochanters pale yellow; femora and tibiæ pale brown; tarsi brownish black. Wings (Plate 1, fig. 18) subhyaline, the short-oval stigma pale brown; veins dark brown. Venation: Sc_1 ending opposite origin of Rs, Sc_2 far back from its tip, Sc_1 exceeding Rs in length; free tip of Sc_2 lying just proximad of R_2; cell 1st M_2 open by the atrophy of m; M_{3+4} longer than vein M_4; m-cu at or shortly before fork of M.

Abdominal tergites brown, the sternites obscure yellow, the incisures very vaguely and narrowly more darkened. Male hypopygium (Plate 4, fig. 48) with the tergite, 9*t*, deeply emarginate, the lobes with numerous setæ. Basistyle, *b*, with the ventromesal lobe long and conspicuous, densely setiferous. Ventral dististyle, *vd*, large and fleshy, the rostral prolongation with three subequal spines near base, these placed rather close together, not from enlarged basal tubercles. Ovipositor with the cerci very slender, upcurved.

Habitat.—Kashmir.

Holotype, male, Doku, Baltistan, altitude 10,000 feet, September 9, 1934 (*Hutchinson*). Allotopotype, female. Paratopotype, female; paratype, male, Skardu, altitude 7,000 feet, September 10, 1934 (*Hutchinson*).

Limonia (*Dicranomyia*) *tricuspidata* is most nearly related to *L.* (*D.*) *immodestoides* (Alexander), widely distributed in eastern Asia, differing especially in the somewhat longer vein Sc, and in the structure of the male hypopygium, as the elongate ventromesal lobe of the basistyle and the trispinous prolongation of the ventral dististyle. *Limonia* (*D.*) *patens* (Lundström), of northern Europe and eastern Siberia, is likewise a member of this group, yet very different from the two species abovementioned. *Limonia* (*D.*) *absens* (Brunetti), of the eastern Himalayas, differs in the coloration of the body and legs and in the more elongate cell M_3 of the wings, this being nearly twice as long as its petiole. This latter species is still known only from the female sex.

LIMONIA (DICRANOMYIA) BIFUSIFERA (Edwards).

Dicranomyia bifusifera EDWARDS, Ann. & Mag. Nat. Hist. IX 20 (1927) 225–226.

Described from a unique male taken in Kashmir, without exact locality, altitude 11,000 to 13,000 feet, collected by Mitchell. Five males, Pulwar Nullah, Kashmir, altitude 11,000 feet, October 8, 1934 (*Hutchinson*).

These specimens differ somewhat from Edwards's description in the details of coloration and venation, but the peculiar hypopygium is identical, and I have little doubt of the determination. General coloration of the entire thorax dark gray. Legs brown to brownish black, the femoral bases brighter. Wings with Sc_1 much shorter than Rs, somewhat variable in the present series, ranging from one-third to one-fifth the length of Rs.

ANTOCHA (ANTOCHA) PICTURATA sp. nov. Plate 1, fig. 19.

Mesonotal præscutum reddish, with a gray pruinosity; a median brown stripe on præscutum; halteres and legs pale; wings milky white, with a handsome, pale gray, clouded pattern, including clouds in cells R, M, and R_3; vein R_2 in transverse alignment with r-m; cell 1st M_2 relatively small; m-cu shortly before fork of M.

Female.—Length, 5 to 5.5 millimeters; wing, 4.5 to 5.

Rostrum and palpi brownish black. Antennæ black, the pedicel a little paler; flagellar segments short-oval. Head dark gray.

Mesonotal præscutum reddish, with a gray pruinosity; a median brown stripe on præscutum, becoming obsolete before the suture; posterior sclerites of notum gray, the scutellum paler. Pleura chiefly brownish yellow. Halteres pale. Legs with the coxæ and trochanters yellow; remainder of legs chiefly yellow, only the terminal tarsal segments more darkened. Wings (Plate 1, fig. 19) milky white, with a handsome, pale gray, clouded pattern, including the stigma, cord, outer end of cell 1st M_2, all of vein 2d A, and distal third of 1st A; clouds in cells R and M opposite the origin of Rs, and near the outer end of cell R_3; veins pale, darker brown in the clouded areas. Venation: R_2 in transverse alignment with r-m; cell 1st M_2 relatively small, the second section of vein M_{1+2} shorter than the last section; m-cu shortly before the fork of M.

Abdomen pale brown to brownish yellow, the posterior borders of the segments restrictedly paler.

Habitat.—China (Szechwan).

Holotype, Gehang, October 5, 1934 (*Franck*). Paratopotype, female.

The handsomely patterned wings readily separate the present fly from all regional species, excepting *Antocha* (*Antocha*) *bifida* Alexander, *A.* (*A.*) *nebulosa* Edwards, and *A.* (*A.*) *nebulipennis* Alexander. The more-involved and complicated wing pattern and the uniformly pale yellow legs readily distinguish the present fly.

ORIMARGA (ORIMARGA) BASALIS sp. nov. Plate 1, fig. 20.

General coloration gray; rostrum and base of scape reddish; halteres whitish throughout; femora pale brown, with a slightly indicated, darker brown, subterminal ring; wings pale yellow, veins yellow, Cu and 2d A darker; R_{2+3} elongate, subequal to Rs; m-cu lying unusually far basad, opposite origin of Rs.

Male.—Length, about 7 millimeters; wing, 6.5.

Female.—Length, about 7.5 to 8 millimeters; wing, 6.3 to 7.

Rostrum reddish; palpi a little darker. Antennæ with basal portion of scape reddish, the remainder of organ black; flagellar segments oval, the outer ones a trifle more elongate, with short verticils. Head gray, slightly more brownish gray behind.

Mesonotum gray, in cases with the præscutum having indistinct more brownish lines on the interspaces. Pleura more or less pruinose, especially the dorsal portion, the ventral region paler and, in cases, more reddish. Halteres whitish throughout. Legs with the coxæ and trochanters pale; femora pale brown or yellowish brown, becoming narrowly darker just before the pale

tips; in cases, the femora are more evenly and generally darkened; tibiæ and tarsi darker brown. Wings (Plate 1, fig. 20) almost uniformly pale yellow, the prearcular field whitened; axillary region narrowly darkened; veins yellow, Cu, 2d A, and basal portion of 1st A darker. Macrotrichia of veins beyond cord abundant, there being a series of more than thirty on vein R_3. Venation: Sc relatively long, Sc_1 ending a short distance before fork of Rs, Sc_2 near its tip; R_{2+3} elongate, subequal to or only a little shorter than Rs and exceeding twice R_{1+2} alone; basal section of R_{4+5} long, exceeding R_{1+2}; r-m lying a short distance basad of R_2; m-cu lying unusually far basad, opposite the extreme basal portion of Rs.

Abdominal tergites dark brown, the sternites a trifle paler, more yellowish brown.

Habitat.—Kashmir.

Holotype, male, Skardu, altitude 7,000 feet, July 12, 1934, in marshy area, associated with *Gonomyia* (*Ptilostena*) *reticulata* Alexander (*Hutchinson*). Allotopotype, female. Paratopotypes, males and females, altitude 7,000 to 7,700 feet, July 3 to 12, 1934 (*Hutchinson*).

All species of *Orimarga* hitherto made known from British India and the Himalayas have vein R_{2+3} short, less than one-third the length of Rs. The present fly is most closely allied to certain species from Japan and western China, such as *Orimarga* (*Orimarga*) *formosicola* Alexander, *O.* (*O.*) *omeina* Alexander, *O.* (*O.*) *pruinosa* Alexander, and *O.* (*O.*) *yakushimana* Alexander, differing from all in the pattern of the femora and the position of m-cu opposite the extreme base of Rs, thus making the second section of vein M of unusual length.

HEXATOMINI

PSEUDOLIMNOPHILA APICINIGRA sp. nov. Plate 1, fig. 21.

General coloration of head and thorax gray; antennæ with scape dark brown, the pedicel a little paler; basal segment of flagellum obscure brownish yellow; outer flagellar segments cylindrical, with long conspicuous verticils that much exceed the segments in length; præscutum with two intermediate darker gray stripes that are separated by a capillary brown vitta; femora obscure yellow, the tips narrowly blackened; wings yellowish brown, the small stigma pale brown; R_{1+2} longer than the strongly erect R_{2+3+4}; R_{2+3} a little shorter than R_{2+3+4}; cell M_1 about twice its petiole; m-cu a little proximad of r-m; anterior

arculus preserved; abdominal tergites dark brown, the sternites yellowish.

Male.—Length, about 8.5 millimeters; wing, 8.

Female.—Length, about 9 to 10 millimeters; wing, 8.5 to 9.

Rostrum and palpi dark brown. Antennæ with the scape dark brown; pedicel a little paler; basal segment of flagellum obscure brownish yellow to brown; remaining segments passing into black; outer flagellar segments cylindrical, with long conspicuous verticils that much exceed the segments in length. Head gray; anterior vertex wider than the diameter of scape.

Mesonotal præscutum gray, with indications of two darker gray submedian stripes and more brownish lateral stripes; intermediate stripes separated by a capillary brown vitta; pseudosutural foveæ and tuberculate pits black; posterior sclerites of notum gray. Pleura gray. Halteres pale, the knobs weakly infumed. Legs with the coxæ and trochanters pale yellow; femora obscure yellow, the tips narrowly but conspicuously blackened, the amount subequal on all legs; tibiæ light brown, the tips very narrowly infuscated; basitarsi brown, the tips brownish black; outer tarsal segments black. Wings (Plate 1, fig. 21) with a strong yellowish brown tinge, the costal and prearcular regions, together with cell Cu_1, somewhat more yellowish; stigma very small and pale, scarcely differentiated; veins brown. Macrotrichia of veins abundant and of moderate length. Venation: Sc_1 ending nearly opposite fork of Rs, Sc_2 a short distance from its tip; R_1 incrassated opposite R_2; R_{1+2} longer than the strongly erect R_{2+3+4}; R_{2+3} a little shorter than R_{2+3+4}; cell M_1 about twice its petiole; m-cu lying a little proximad of r-m, not far beyond fork of M; anterior arculus preserved.

Abdominal tergites dark brown; sternites yellowish.

Habitat.—Kashmir.

Holotype, male, Skardu, altitude 7,700 feet, July 3, 1934 (*Hutchinson*). Allotopotype, female. Paratopotype, female.

In the suberect vein R_{2+3+4} the present fly is rather similar to the Japanese *Pseudolimnophila erecta* Alexander, an otherwise very different species, having R_{1+2} short and m-cu beyond midlength of cell 1st M_2. The Indian species that are most closely allied are *P. fusca* (Brunetti) and *P. pallidicoxa* (Brunetti), from both of which the present fly is readily told by the gray coloration of the head and thorax, the uniformly pale abdominal sternites, and the black-tipped femora. As indicated by Ed-

wards [4] the species *pallidicoxa* was evidently founded on a mixture of two genera and the identity of the holotype specimen is in doubt. A paratype in my collection, which seems to agree well with Brunetti's conception of the species in 1912, when the insect was described (but not in 1918, when Brunetti keyed the Oriental species of the group and gave a figure of *pallidicoxa* as he then construed the species) is evidently allied to the present fly, but differs venationally in the longer and less erect R_{2+3+4} and the smaller cell 1st M_2.

HEXATOMA (ERIOCERA) LUXURIOSA sp. nov. Plate 1, fig. 22.

Belongs to the *nepalensis* group; mesonotal præscutum in front fiery orange, scutum and parascutella brownish black, mediotergite dull yellow; pleura uniformly dark liver brown; antennæ and legs dark brown; wings dark brown, the anal cells paler; a conspicuous white discal area before the cord; R_2 transverse, R_{1+2} subequal to R_{2+3}; cell M_1 lacking; m-cu near outer end of cell 1st M_2; abdomen black, the basal rings of segments two to six (female) and two to seven (male) polished nacreous; genital segment of female orange; male hypopygium black; subterminal segments in male expanded into a weak spatula.

Male.—Length, about 15 millimeters; wing, 15.

Female.—Length, about 18 millimeters; wing, 13.

Rostrum black; palpi brownish black. Antennæ brownish black throughout. Head dull black; vertical tubercle small, with a lower, less evident tubercle immediately in front of it.

Prothorax dark liver brown. Mesonotal præscutum in front and on sides deep fiery orange, becoming more infuscated behind; scutum and parascutella dark brown or brownish black; scutellum obscure orange; mediotergite dull yellow, unmarked. Pleura and pleurotergite, including dorsopleural membrane, uniformly dark liver brown, unmarked. Halteres dark brown. Legs dark brown throughout, femoral bases unbrightened. Wings (Plate 1, fig. 22) almost uniformly suffused with dark brown, including the prearcular field and costal region; anal cells paler, except as a seam along vein 2d A; a conspicuous white area before the cord, including cells R_1, R, and M, not quite reaching veins R_1 and Cu, the distal edge reaching the fork of Rs, a little wider in cells R and M; veins brown, yellow in the

[4] Rec. Indian Mus. 26 (1924) 302.

white discal band. Macrotrichia of veins beyond cord small and sparse, or lacking. Venation: Sc_1 ending shortly before R_2, the latter transverse; R_{1+2} subequal to or longer than R_{2+3}; cell M_1 lacking; m-cu near outer end of cell 1st M_2.

Abdomen dull black, segments two to six (female) and two to seven (male) with the basal rings polished nacreous; outer segments in male more uniformly dull black; ovipositor and genital segment fiery orange; in male, segments five to seven gently expanded into a weak spatula, hypopygium black.

Habitat.—Siam.

Holotype, male, Chieng-mai, October 25, 1920; American Museum of Natural History F 4564; accession No. 22,628. Allotopotype, female, F 4560, in author's collection.

By Edwards's key to the Old World species of *Eriocera*[5] the present fly runs to *Hexatoma* (*Eriocera*) *fenestrata* (Brunetti), which differs in various details of coloration of the thorax and wings. None of the species more recently defined by Edwards and the present writer is more nearly allied to the present insect.

ERIOPTERINI

GONOMYIA (PTILOSTENA) RETICULATA Alexander.

Gonomyia (*Ptilostena*) *recticulata* ALEXANDER, Bull. Mus. Hist. Nat. Paris, for 1921 (1921) 305–306.

The unique type and hitherto only known specimen was from the Gobi Desert, Mongolia, altitude 1,000 to 2,000 meters, collected in June, 1909, by Dr. L. Vaillant. Five males and females, Skardu, Kashmir, altitude 7,700 feet, July 3 to 12, 1934, and 7,000 feet, September 9 and 10, 1934 (*Hutchinson*); at light, and swept from a swampy area where it was associated with *Orimarga* (*Orimarga*) *basalis* sp. nov. and *Pseudolimnophila apicinigra* sp. nov.

The type was badly discolored and the following supplementary notes are given:

Male.—Length, about 6 millimeters; wing, 6.

Female.—Length, 7 to 8 millimeters; wing, 7 to 8.5.

General coloration of thorax gray; præscutum with two intermediate dark brown stripes; humeral region restrictedly yellow; pseudosutural foveæ black, conspicuous; scutal lobes variegated by dark brown spots. Pleura gray, with a broken yellow

[5] Ann. & Mag. Nat. Hist. IX 8 (1921) 70–78.

longitudinal stripe that includes the ventral anepisternum, and, in cases, the metapleura; pteropleurite darkened.

ERIOPTERA (ERIOPTERA) PALLICLAVATA sp. nov. Plate 1, fig. 23; Plate 4, fig. 49.

General coloration pale yellow; antennæ, legs, and halteres pale throughout; wings pale yellowish subhyaline, the veins a trifle darker yellow; male hypopygium with the outer dististyle slender, produced into a pale, toothlike lobe at base; gonapophyses appearing as simple darkened blades.

Male.—Length, about 6 millimeters; wing, 6.5.

Rostrum pale; palpi black. Antennæ pale throughout. Head pale yellow; eyes (male) of normal size.

Mesonotum uniformly pale yellow to testaceous-yellow; pleura paler yellow. Halteres white throughout. Legs with the coxæ and trochanters pale yellow; remainder of legs yellow, the terminal tarsal segments passing into dark brown. Wings (Plate 1, fig. 23) pale yellowish subhyaline, the veins a trifle darker yellow; macrotrichia light brown. Venation: Sc_1 ending just before R_2, Sc_2, not evident in the unique type; distal end of vein Cu_1 deflected suddenly cephalad; vein 2d A very strongly bent at midlength, the outer half paralleling the posterior border of wing.

Abdomen pale brownish yellow, the lateral borders a little darkened. Male hypopygium (Plate 4, fig. 49) with a small subapical lobe on mesal face of basistyle, *b*, near apex. Outer dististyle, *od*, slender, with a pale toothlike extension at base, the apex a trifle enlarged and darkened. Inner dististyle, *id*, strongly twisted at near two-thirds the length, the apex a narrowly darkened spine. Gonapophyses, *g*, appearing as simple darkened blades.

Habitat.—Kashmir.

Holotype, male, Minimarg, September 14, 1934 (*Hutchinson*).

By Brunetti's key to the Indian species of *Erioptera*[6] the present fly runs to *Erioptera flava* Brunetti (preoccupied, renamed *bengalensis* Alexander), which belongs to the subgenus *Meterioptera*. The present fly is a true *Erioptera*, apparently most nearly allied to *E.* (*E.*) *xanthoptera* Alexander,[7] of northern Japan. The latter species, still known only from the female sex, is dark brown, with the wings more strongly suffused with

[6] Brit. India, Diptera Nematocera (1912) 448–449.
[7] Philip. Journ. Sci. 24 (1924) 582.

yellow. Among the European species, the present fly is most generally similar to *E.* (*E.*) *flavescens* (Linnæus) and *E.* (*E.*) *meijerei* Edwards, differing conspicuously in the structure of the male hypopygium.

ORMOSIA SECLUSA sp. nov. Plate 1, fig. 24; Plate 4, fig. 50.

Mesonotum varying from reddish brown to gray, the pleura gray; halteres pale yellow throughout; wings with a brown tinge, the prearcular and basal costal regions more yellowish; cell M_2 open by the atrophy of the basal section of M_3; veins M_3 and m not angulated at point of union; vein 2d A sinuous on outer third; male hypopygium with the gonapophyses appearing as long slender black spines, each with two or three smaller spines near tip and with a long slender spine on outer face at near mid-length.

Male.—Length, about 4 to 4.3 millimeters; wing, 5 to 5.5.

Female.—Length, about 5.5 millimeters; wing, 6.

Rostrum and palpi black. Antennæ brownish black, of moderate length in male, if bent backward ending before wing root. Head dark gray.

Pronotum and mesonotum varying in color in different specimens, in some grayish brown to darker gray, in others more reddish brown; humeral triangle restrictedly brightened. Pleura brownish gray. Halteres pale yellow throughout. Legs with the coxæ dark reddish brown; trochanters obscure yellow; femora yellow basally, passing into yellowish brown; tibiæ obscure yellow, the tarsi passing into dark brown. Wings (Plate 1, fig. 24) with a brown tinge, the prearcular and basal costal regions more yellowish; stigmal region slightly darker brown; veins stout, pale brown, indistinctly seamed with brown. Venation: R_{2+3+4} and R_{2+3} subequal, a trifle exceeding R_2 alone; cell M_2 open by atrophy of basal section of M_3; m and outer section of M_3 not angulated at point of union; m-cu at or just before fork of M; vein 2d A sinuous on outer third.

Abdomen dark brown, the hypopygium a little brighter. Male hypopygium (Plate 4, fig. 50) with the ninth tergite, *9t*, relatively narrow. Basistyle, *b*, not produced. Outer dististyle, *od*, a small, earlike structure, set with abundant appressed microscopic setulæ. Inner dististyle, *id*, with the apex narrowed into a slender curved sclerotized arm, the notch filled with pale membrane. Gonapophyses, *g*, appearing as long slender black spines, each with two or three smaller appressed spines on outer

margin back from tip, and a longer slender black spine more basal in position at near midlength of the outer face of the apophysis.

Habitat.—Japan (Honshiu).

Holotype, male, Konseitoge, Shimotsuke, altitude 7,000 feet, August 6, 1934 (*Issiki*). Allotype, female, pinned with type. Paratopotypes, 3 males and females.

The structure of the male hypopygium, and especially of the peculiarly formed gonapophyses, is very different from that of all allied regional species of *Ormosia,* such as *O. takahashii* Alexander and *O. takeuchii* Alexander.

ILLUSTRATIONS

[*a*, Ædeagus; *b*, basistyle; *c*, cercus; *d*, dististyle; *g*, gonapophysis; *id*, inner dististyle; *od*, outer dististyle; *s*, sternite; *t*, tergite; *vd*, ventral dististyle.]

Plate 1

Fig. 1. *Trichocera alticola* sp. nov., venation.
2. *Trichocera glacialis* sp. nov., venation.
3. *Trichocera abieticola* sp. nov., venation.
4. *Ctenacroscelis nimbus* sp. nov., venation.
5. *Tipula* (*Sinotipula*) *hutchinsonæ* sp. nov., venation.
6. *Tipula* (*Acutipula*) *irrequieta* sp. nov., venation.
7. *Tipula* (*Oreomyza*) *baltistanica* sp. nov., venation.
8. *Tipula* (*Oreomyza*) *venerabilis* sp. nov., venation.
9. *Tipula* (*Oreomyza*) *icarus* sp. nov., venation.
10. *Tipula* (*Lunatipula*) *hypovalvata* sp. nov., venation.
11. *Tipula xanthocera* sp. nov., venation.
12. *Nephrotoma inconsequens* sp. nov., venation.
13. *Nephrotoma parascutellata* sp. nov., venation.
14. *Nephrotoma meraca* sp. nov., venation.
15. *Nephrotoma trilobulata* sp. nov., venation.
16. *Nephrotoma irrevocata* sp. nov., venation.
17. *Limonia* (*Limonia*) *protrusa* sp. nov., venation.
18. *Limonia* (*Dicranomyia*) *tricuspidata* sp. nov., venation.
19. *Antocha* (*Antocha*) *picturata* sp. nov., venation.
20. *Orimarga* (*Orimarga*) *basalis* sp. nov., venation.
21. *Pseudolimnophila apicinigra* sp. nov., venation.
22. *Hexatoma* (*Eriocera*) *luxuriosa* sp. nov., venation.
23. *Erioptera* (*Erioptera*) *palliclavata* sp. nov., venation.
24. *Ormosia seclusa* sp. nov., venation.

Plate 2

Fig. 25. *Trichocera alticola* sp. nov., ovipositor, cercus, lateral.
26. *Trichocera glacialis* sp. nov., male hypopygium.
27. *Trichocera abieticola* sp. nov., male hypopygium.
28. *Ctenacroscelis nimbus* sp. nov., male hypopygium, details.
29. *Tipula* (*Sinotipula*) *hutchinsonæ* sp. nov., male hypopygium.
30. *Tipula* (*Sinotipula*) *hutchinsonæ* sp. nov., male hypopygium, details.
31. *Tipula* (*Acutipula*) *irrequieta* sp. nov., male hypopygium.
32. *Tipula* (*Oreomyza*) *baltistanica* sp. nov., male hypopygium.
33. *Tipula* (*Oreomyza*) *baltistanica* sp. nov., male hypopygium, styli.

Plate 3

Fig. 34. *Tipula* (*Oreomyza*) *venerabilis* sp. nov., male hypopygium, details.
35. *Tipula* (*Oreomyza*) *icarus* sp. nov., male hypopygium.

FIG. 36. *Tipula* (*Oreomyza*) *icarus* sp. nov., male hypopygium, details.
37. *Tipula* (*Lunatipula*) *submarmoratipennis* sp. nov., male hypopygium, details.
38. *Tipula* (*Lunatipula*) *submarmoratipennis* sp. nov., male hypopygium, details.
39. *Tipula* (*Lunatipula*) *hypovalvata* sp. nov., male hypopygium.
40. *Tipula* (*Lunatipula*) *hypovalvata* sp. nov., male hypopygium, details.
41. *Tipula xanthocera* sp. nov., male hypopygium, details.
42. *Tipula xanthocera* sp. nov., male hypopygium, details.

PLATE 4

FIG. 43. *Nephrotoma inconsequens* sp. nov., male hypopygium, details.
44. *Nephrotoma parascutellata* sp. nov., male hypopygium, details.
45. *Nephrotoma meraca* sp. nov., male hypopygium, details.
46. *Nephrotoma trilobulata* sp. nov., male hypopygium, details.
47. *Nephrotoma irrevocata* sp. nov., male hypopygium, details.
48. *Limonia* (*Dicranomyia*) *tricuspidata* sp. nov., male hypopygium.
49. *Erioptera* (*Erioptera*) *palliclavata* sp. nov., male hypopygium.
50. *Ormosia seclusa* sp. nov., male hypopygium.

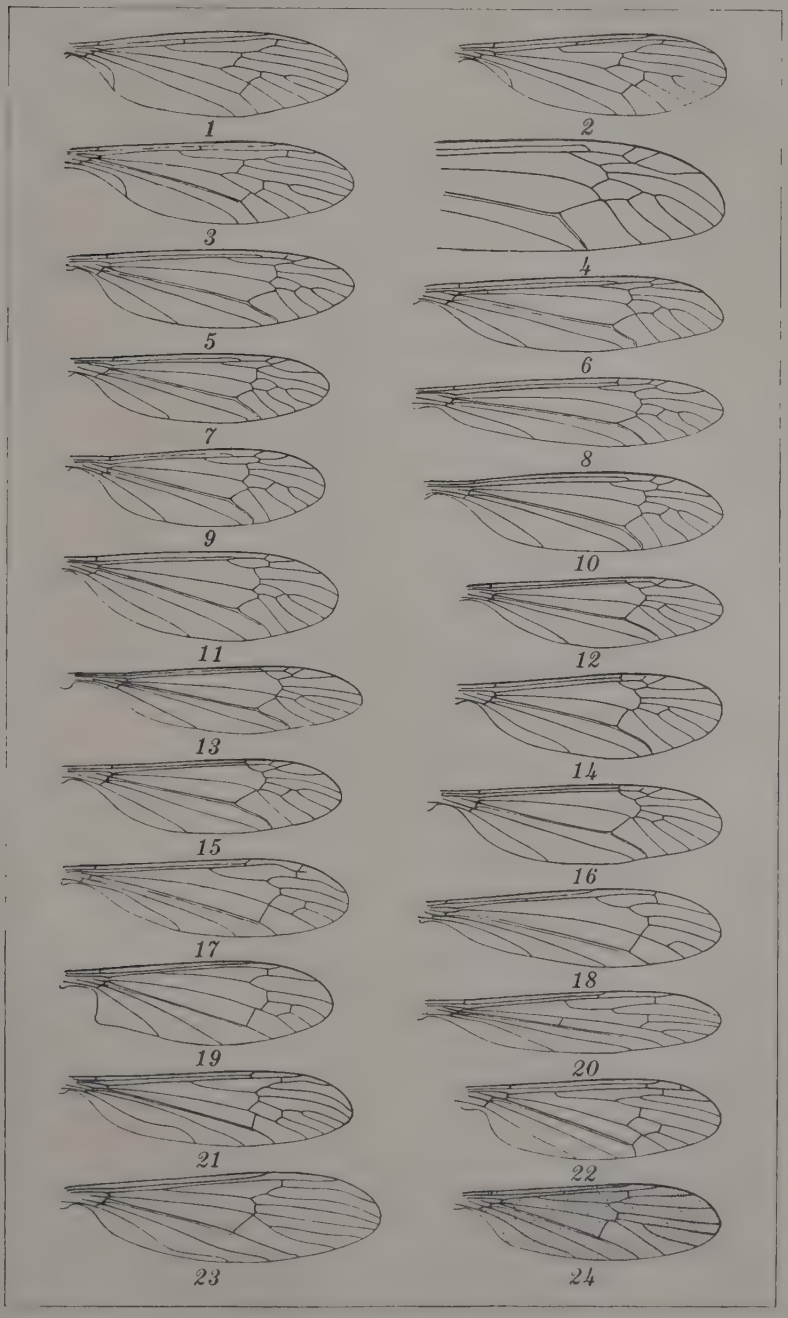

PLATE 1.

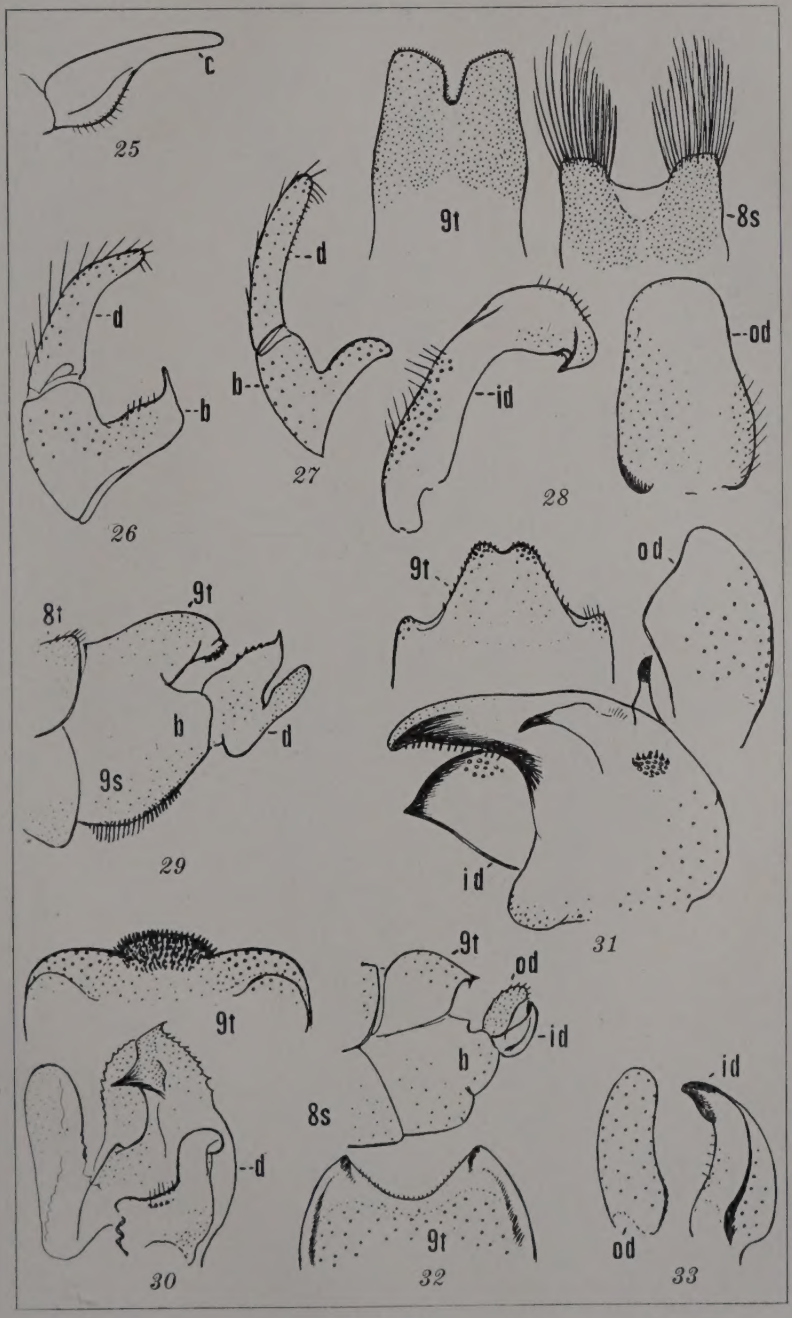
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PLATE 2.

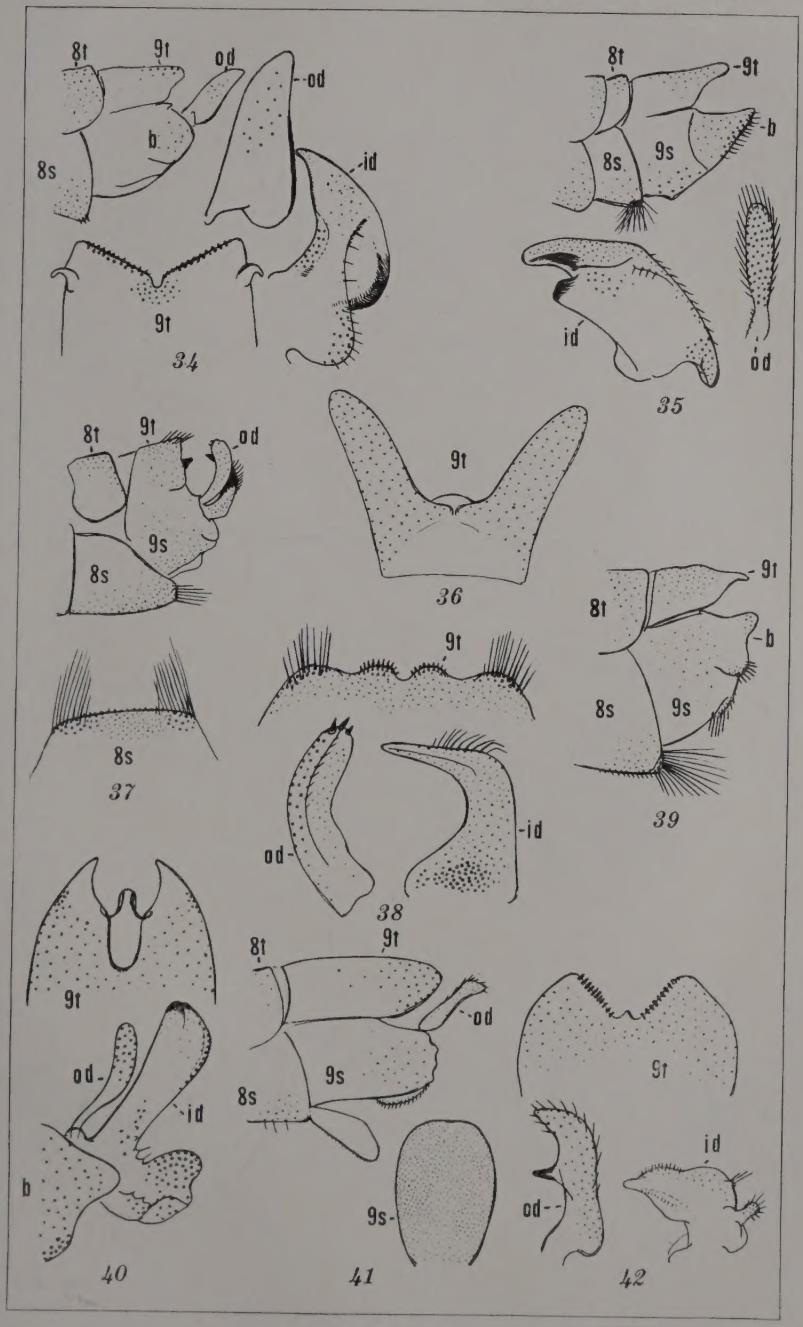
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PLATE 3.